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The Practical Teacher

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Edited by JOSEPH HUGHES.

'Knowledge is proud that he has learned so much,
Wisdom is humble that he knows no more.'—COWPER.

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ARITHMETIC PRIZE PAPERS.

BY W. P. WORKMAN, M.A., B.SC.,
Head Master of Kingswood School; late Fellow of Trinity College, Cambridge.

ARITHMETIC PRIZE PAPER, NO. III.—[K. S. 1892.]

1. Complete the following multiplication and division sums :—

(1)
$$\begin{array}{r} 4\,-\,- \\ \times\quad 3\,- \\ \hline 3\,6\,-\,- \\ -\,-\,7\,- \\ \hline -\,-\,3\,-\,- \end{array}$$

(2)
$$\begin{array}{r|l} -\,-\,-\,)5\,-\,-\,5\,-\,-(-\,-\,-\,- & \\ \quad -\,-\,- & \\ \hline \quad 7\,5\,- & \\ \quad -\,-\,- & \\ \hline \quad\quad 1\,7\,- & \\ \quad\quad -\,-\,3 & \\ \hline \quad\quad\quad -\,3\,- & \\ \quad\quad\quad -\,-\,- & \\ \hline \quad\quad\quad\quad -\,5 & \end{array}$$

2. Simplify:—

(1) $\dfrac{1+\lfloor 12}{13^2}$

(2) $\dfrac{\sqrt{115^2+236^2}}{\sqrt{9^2+40^2}} \times \dfrac{\sqrt{9^3+46^2}}{\sqrt{5^2+12^2}}$

3. Factorize (1) $2^{54}+1$, (2) $2^{55}+1$, (3) $2^{56}+1$, (4) $2^{57}+1$ (5) $2^{58}+1$.

4. A man leaves £162,625 to his two sons, aged just 19 and 17 years respectively, each son to receive the same sum when he comes of age. Assuming the money to accumulate at the rate of 4 per cent. per annum, compound interest, determine the amount which should be paid to the elder when he comes of age.

5. A watch is set correctly at noon, but gains at a uniform rate. It is noticed that the hands are together between the figures V and VI, when it is really 5 o'clock. At what (true) time will the hands be together again?

6. Explain by what process you would derive the decimal value of $\frac{1}{n-1}$ from $\frac{1}{n}$, and apply your process to calculate to 30 places the value of $\frac{1}{1000}+\frac{1}{999}+\frac{1}{998}+\frac{1}{997}+\frac{1}{996}$.

7. Prove that $4x^2+1,481,481,451,831,861$ is an exact square, when $x = 123,456,787,654,321$, and find its square root.

8. Find the fifth root of 28,153,056,843 (an exact fifth power), and deduce to 16 places of decimals the fifth root of 28,153,056,844.

9. Perform the following operations in scale 20 in which $\ell = 10$, $\epsilon = 11$, $\wp = 12$, $\mathfrak{w} = 13$, etc.

(1) Add together $\cdot 1$, $\cdot 2\dot{\wp}$, $\cdot 3\mathfrak{w}\dot{3}$, $\cdot 4\epsilon 5\dot{\imath}\wp$.

(2) Subtract $\cdot 3\mathfrak{w}\dot{3}$ from $\cdot 4\epsilon 5\dot{\imath}\wp$.

(3) Convert $\frac{1}{23}$ (scale 10), $\frac{1}{23}$ (scale 20), into vicesimals.

(4) Multiply 1111 by *tttt*, and divide $3723\wp\infty 4\imath\wp$ by $21\imath\wp\imath\wp$.

(5) Find the fourth root of $\dfrac{1\wp\,\imath\,1}{3723\wp\infty 4\wp}$.

10. It being given that 65537 is a prime number, prove that the number of places in the recurring period of $\frac{1}{65537}$ is a power of 2, and that the same is true of the vicesimal fraction $\frac{1}{83\wp\,\imath}$.

11. Find, correct to 30 places of decimals, the value of—

$$\frac{999,999,990}{999,999,999} \times \frac{999,999,992}{999,999,997} \times \frac{999,999,994}{999,999,995} \times \frac{999,999,996}{999,999,993} \times \frac{999,999,998}{999,999,991}$$

12. Prove that if $a_n\, a_{n-1} \ldots a_2\, a_1$ be the digits of a number in scale 7, the number is divisible by 19 if $(a_1+a_4+a_7+\ldots.) + 7(a_2+a_5+a_8+\ldots.) - 8(a_3+a_6+a_9+\ldots.) = 0$ or a multiple of 19.

13. Construct Rules of Divisibility applicable to scale 12.

14. Find all the prime numbers lying between 5,000 and 5,100. How would you proceed systematically to determine the primes lying between, say, 1,000,000 and 2,000,000?

15. In the course of a year of $365\frac{1}{4}$ days the planet Mars traverses 689050·8013 seconds of angular measurement of its own annual course. Supposing that the Martians divide their year into months, of which 4 have 29 days, and the rest 30 days, and that their days are the same length as ours, suggest how Pope Gregory should arrange their leap year for them.

Erratum.—Ex. 5, p. 401, is affected by a rather serious error which while it leaves the result unaffected completely alters the value given for the decimal. I owe the discovery of this error to the kindness of Mr. H. Taylor, of Herne Hill, London.

Substitute the following working :—

383)1000(·00261096605744125
2340
420
3700
2530
2320
2200
2850
1690
1580
480
970
2040
125 ; this being $\frac{1}{8}$ of 1000,

the rest of the work can be accomplished at once by dividing by 8 ;

$$\frac{1}{383} = \cdot 00261096605744125$$
$$326370757180 15$$
$$6657963446751$$
&c., &c.,

and as recurrence does not take place at the 191st figure it can

be predicted without further work that it takes place at the 382nd figure. The remainder of the proof is as printed.

The complete value of the decimal is as follows :—

·002610,966057,441253,263707,571801,566579,
634464,751958,224543,080939,947780,678851,
174934,725848,563968,668407,310704,960835,
509138,381201,044386,422976,501305,483028,
720626,631853,785900,783280,817232,375979,
112271,540469,973890,339425,587467,362924,
281984,334203,655352,480417,754569,190600,
522193,211488,250652,741514,360313,315926,
892950,391644,908616,187089,556135,770234,
986945,169712,793733,681462,140992,167101,
827676,240208,877284,595$\frac{3}{4}$.

The figures after the 134th are obtained by dividing the initial figures by 2, and the figures from the 192nd to the end by subtracting the first and following figures from 9.

Mr. Taylor has also kindly drawn attention to the following additional errata :—

p. 400, Col. 2. Question 3 (*d*), first line—*for* ·1694915 *read* ·01694915...

p. 402, Col. 1. Line 2—*for* 11 × 313 *read* 11 × 383.

p. 402, Col. 2. Question 9 (1). The last four figures of the answer should be 9 $\frac{1}{2}$, instead of 92$\frac{1}{2}$. The same correction must be made 5 lines further down.

p. 403, Col. 1. Question 9 (6). The answer is 31 +, not 310. And this correction should be made in the two places where 310 occurs, while 620 should be changed to 62 +.

It is only fair to the printers to add that their part of this work has been done with marvellous correctness, and the occurrence of these errors must be attributed to the fact that I have no friend of whose friendship I am sufficiently sure that I dare ask him to undertake the enormous labour of checking my MSS.

NEW PROBLEMS IN ARITHMETIC.

BY T. B. ELLERY, F.R.G.S.,
Vice-President National Union of Teachers.

7TH PAPER.

STANDARD II.

FOR introduction, *see* October No. of *The Practical Teacher*. For other remarks on the same subject I refer my readers to the *Girls' Mistress* for September 1st last, in which appears the first of a series of papers on *Standard Problems for Girls, and How to Solve them*. In passing let me say :—

1. Every exercise here given will suggest to the practical teacher many others of the same kind.
2. The blackboard should be freely used in the solution of these problems.

Here, again, many of the exercises may be found beyond some of the children in the Standard, but each will form the basis of a good lesson, and the whole set, carefully worked on the blackboard and by the children, will give excellent practice and help considerably in the preparation for the work of the next higher Standard.

A.

1. What is the fifth part of the sum of 186 and 94?
2. How many dozens are there in the sum of 96, 124, and 20?
3. Take 286 from eleven hundred, and multiply your answer by 180.
4. A man bought 1,380 apples in five days. On the first day he bought 200, on the second 156, on the third 485, and on the fourth 240. How many did he buy on the fifth day?
5. I buy 200 nuts, and then 340 more. How many dozen have I?
6. A man is 58 years old. How many days has he lived, reckoning 365 days in a year?
7. A postman walks 24 miles a day six days in the week. He is ill on one day in a certain week. How many miles does he walk that week?
8. There are 140 children in four classes. In the first class there are 24 boys, in the second class 38, and in the third class 46. How many in the fourth?
9. In a book of 96 pages there are 24 lines on each page, and eight words on each line. How many words in the book?
10. Jane has 64 nuts, and Emily has three times that number. Rose has as many as Jane and Emily together. How many has Rose?
11. I spend eightpence in nuts, and receive two bags, one containing 240 nuts, and the other 160 nuts. How many do I receive for one penny?
12. A man earns 8 pence per hour. He works 10 hours a day for 12 days. How many pennies has he earned in that time?
13. How many nuts should I require to give 38 girls seven each, and the same number of boys eight each?
14. There are 12 houses in a row. Each house has 12 windows, and in each window there are 16 panes. How many panes are there in the 12 houses?
15. I have a book containing 240 pages. On each of 8 days I read 24 pages. How many pages are then unread?

B.

16. If each of 19 boys and 17 girls receive 24 marbles, how many less than a thousand are given away?
17. I had three hundred and sixty apples. I kept 85, and divided the rest equally among eleven men. How many did each man receive?
18. I have seven boxes, each containing sixty-four oranges. To how many men can I give 8 oranges each?
19. I gave eighteen nuts to each of 20 boys and 25 girls, and had a hundred and fifty left. How many had I at first?
20. There were 256 boys and 278 girls in a certain school. To each of these three dozen nuts were given. How many nuts were given away?
21. Fred had 36 nuts, Tom had twice that number, and Harry had as many as Fred and Tom together. How many had they in all?
22. There are 380 children in the boys' department of a school, 366 in the girls' department, and 428 in the infants' department. A gentleman gave each of these children a dozen nuts. How many nuts did he give away?
23. A man put 350 marbles into ten bags. He put three dozen into each of nine of the bags. How many did he put into the tenth?
24. A fruiterer bought first 240 oranges, and then 310 more. He put these into 11 boxes, an equal number in each. How many oranges were in each box?
25. I can buy a horse for £16, and a cow for £18. What shall I pay in all for 18 horses and 16 cows?

BRITISH MUSEUM

26. A man owes 68 pence to one man, 54 to another, and 46 to another. How many shillings does he owe, there being 12 pence in a shilling?

27. A boy bought 8 dozen marbles. He gave 4 to each of 9 boys, and then won seventeen. How many had he then?

28. A farmer bought 24 cows on each of 3 days. He then sold one half of the number he had, and two others died. How many had he then?

29. A youth earned eighteen pennies every day for sixteen days, and then twenty pennies every day for eighteen days. How many pennies did he earn altogether?

30. There were 180 sheep in one field, and 136 in another. 76 were taken from the first field and sold. From the second field 57 were taken. How many were left altogether in the two fields?

C.

31. A man bought 300 apples at 5 a penny, and sold them at 4 a penny. How many pennies did he gain?

32. A man had 42 pennies in one bag, and three times that number in another. There are twelve pennies in a shilling. How many shillings had he in all?

33. A woman had 250 apples. She used half of them, and afterwards gave six to each of her four children. How many had she then?

34. In a school of 264, one fourth of the boys received 16 marbles each, and the remainder a dozen each. How many marbles were given away?

35. A man spends eight shillings each week day, and ten shillings on Sunday. How much does he spend in a month of 4 weeks?

36. A gent'eman left 560 sovereigns to each of his four sons, and 350 sovereigns to each of his three daughters, and to his widow he left a thousand sovereigns. How many sovereigns did he leave altogether?

37. I bought a dozen boxes, each containing 36 pears. I kept one half of these pears, and sold the rest at a penny each. How many pennies did I receive?

38. One man gave me 58 apples, and another gave me 62. I divided these equally among 5 boys and 3 girls. How many did each receive?

39. There were 68 boys in a certain class, and each boy had 4 sums to work. 45 boys sent in 4 right answers, and the rest sent in 3 right answers. How many right answers were sent in altogether?

40. 268 people ride in an omnibus during the day. Of these 145 pay one penny, 98 pay twopence, and the others pay threepence. How many pennies are paid in all?

41. I cut each of 48 apples into 4 pieces, and gave 6 pieces to each of 18 boys and 10 girls. How many pieces were left?

42. In a certain school there were 416 boys and girls, and of these 228 were girls. Each boy received 3 oranges, and each girl 2. How many oranges were given away?

43. I have 12 sixpences in a bag, and 9 shillings in another bag. If I change this money into pence, to how many children can I give a penny each?

44. Tom has 124 marbles, and Fred has 20 more than that number. If I had 8 more, I should have as many as Tom and Fred together. How many have I?

45. A man bought 360 oranges. A quarter of these he was obliged to throw away, and the rest he sold at the rate of 9 for sixpence. How many pence did he receive?

ANSWERS.

(1) 56.
(2) 20 dozen.
(3) 146,520.
(4) 299 apples.
(5) 45 dozen.
(6) 21,170 days.
(7) 120 miles.
(8) 32 children.
(9) 18,432 words.
(10) 256 nuts.
(11) 50 nuts.
(12) 960 pennies.
(13) 570 nuts.
(14) 2,304 panes.
(15) 48 pages.
(16) 136 marbles.
(17) 25 apples.
(18) 56 men.
(19) 960 nuts.
(20) 19,224 nuts.
(21) 216 nuts.
(22) 14,088 nuts.
(23) 26 marbles.
(24) 50 oranges.
(25) £576.
(26) 14 shillings.
(27) 77 marbles.
(28) 34 cows.
(29) 648 pennies.
(30) 183 sheep.
(31) 15 pennies.
(32) 14 shillings.
(33) 101 apples.
(34) 3,432 marbles.
(35) 232 shillings.
(36) 4,290 sovereigns.
(37) 216 pennies.
(38) 15 apples.
(39) 249 right answers.
(40) 416 pennies.
(41) 24 pieces.
(42) 1,020 oranges.
(43) 180 children.
(44) 260 marbles.
(45) 180 pennies.

WELL-KNOWN TEACHERS AT WORK.

XXXIX.—MR. R. GADIE,

Head Master Park Road Board School, Batley; Treasurer to the West Yorkshire District Union.

THE subject of our present sketch may be truly referred to as one of the 'veterans.' It would be impossible to think of any movement on the part of the West Yorkshire teachers which has taken place during the last quarter of a century with which Mr. Gadie has not in some way or other been connected. On visiting the Park Road School we received a cordial welcome, and such a reception as is characteristic of the thorough Yorkshireman, of whom Mr. Gadie is an excellent specimen. The schools are situated in immediate proximity to the main road, but as they stand in the midst of a commodious playground this disadvantage is somewhat obviated. Mr. Gadie has been in charge of the Park Road Board School since its erection. A brief conversation elicited sufficient facts to convince us that he has gained a valuable experience in scholastic work. He is a native of Settle, Yorkshire. At this town he was one of the first pupil teachers, being bound apprentice in 1848. At the completion of his pupil teachership he won a Queen's Scholarship and entered York Training College, finishing his course there in December 1855. During his last year of training he was selected as night monitor to Archbishop Holgate's School, then known as the Yeoman School, which was connected with the College at that time.

In April 1856 Mr. Gadie took charge of Viscount Downe's School at Danby, near Whitby. Here he laboured for seventeen years, and made a considerable reputation as a successful schoolmaster. The interest which he took in his pupils, apart from their ordinary school duties, was extremely beneficial. The school at Danby was especially commended, and particular

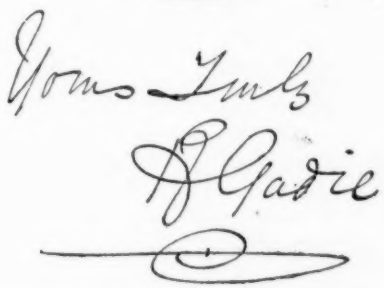
PARK ROAD BOARD SCHOOL, BATLEY.—BOYS' DEPARTMENT.—TIME TABLE.

DAY.	MORNING.							AFTERNOON.						
	Standard.	9—9.10.	9.10—9.40.	9.40—10.30.	10.30—10.45	10.45—11.20.	11.20—12.	1.45—2.	2—2.5.	2.5—2.55.	2.55—3.5.	3.5—3.40.	3.40—4.10.	4.10—4.15.
Monday.	I.	Registers Marked in Red for Punctuality. Spelling, Tables, &c. (whole School).	Prayers, Singing, Scripture (the whole School). Finally close Registers 9.45.	Arithmetic	Recreation (the whole School).	Reading	Writing	Mark Registers in Red; also Tables, &c. (whole School).	Finally Close Registers.	Reading	Recreation (whole School).	Music	Poetry	Singing, Prayers, and Dismissal.
	II.					Reading	Writing			Poetry			Reading	
	III.					Writing	Reading			Poetry			Grammar	
	IV.					Reading	Writing			Poetry			Grammar	
	V.–VII.					Writing	Specific: History (Tudor Period)			Composition			Poetry	
Tuesday.	I.			Writing		*Object Lesson	Arithmetic			Reading		Drawing (all Classes)		
	II.			Writing		*Object Lesson				Geography				
	III.			Geography		Dictation				Dictation				
	IV.			Grammar		Dictation				Geography				
	V.–VII.			Grammar		Composition				Geography				
Wednesday.	I.			Arithmetic		Writing	*Object Lesson			Reading		Tables	School Songs	
	II.			Dictation		Arithmetic	*Object Lesson			Reading		Mental and Tots	School Songs	
	III.			Grammar		Reading	Arithmetic			Writing		Military Drill	Geography	
	IV.			Arithmetic		Reading	Writing			Geography		Military varied by Wand Drill	Arithmetic	
	V.–VII.			Arithmetic		Specific: History	Grammar			Maps or Compostn.		Military Drill occasionally	Music	
Thursday.	I.			Arithmetic		Writing	Reading			Read. or Geography		Drawing (all Classes)		
	II.					Dictation	Reading			Dictation				
	III.					Reading	Writing			Grammar				
	IV.					Reading	Writing			Composition				
	V.–VII.					Geography	Specific: History			Composition				
Friday.	I.			Reading		Writing	Geography			*Object Lesson		Drill	Arithmetic	
	II.			Reading		Writing	Geography			*Object Lesson		Drill	Arithmetic	
	III.			Reading		Geography	Writing			Arithmetic		Reading	School Songs	
	IV.			Reading		Writing	Grammar			Tots		Reading	School Songs	
	V.–VII.			Grammar		Writing	Geography			Tots		Reading	School Songs	

* These Object Lessons are taken in Standards I. and II. in place of English as a Class Subject; yet occasional Lessons are given in Grammar.
Writing Lessons may be a simple Copy or Dictation, or Composition, &c. Two Class Subjects—Standards I. and II., Geography and Object Lessons; in Standard III. and upwards, English and Geography.
One Specific in Standards V., VI., and VII.—History.

mention was made of it in the educational Blue Books. Readers of the Rev. Canon Atkinson's 'Forty Years in a Moorland Parish' will recognise the locality we are now dealing with, and will be interested to learn that the eulogistic references to the parish school contained therein are intended for Mr. Gadie's school. Cricket has always been a favourite pastime with Mr. Gadie, and he imbued his lads with the true sportive spirit whilst at Danby. Many are the miles he and his team have travelled to play friendly games with other schools. A cordial welcome was always accorded them at Lythe, where the Very Rev. the Earl of Mulgrave, now Marquis of Normanby and Dean of Windsor, received them.

It was in 1872 that Mr. Gadie quitted Danby and came to the district of mungo and shoddy, to undertake the supervision of a school in hired rooms under the Batley School Board. After four years' service he was transferred with his pupils to this present school.



During the time that Mr. Gadie has served the Batley Board, great changes have taken place in matters educational in the borough. One of the most serious difficulties that formerly existed was, that it used to be the boast of children, and not a few parents that the pupils yearly attended every school in Batley, either public or private. As a slight testimony to this fact, Mr. Gadie informed us that in one year he admitted eleven hundred children, and yet was unable to present three hundred for examination. It is indeed gratifying to learn that such a remarkable condition of affairs has passed away. As a rule a child remains in the school during the whole of its school life. The uneducational methods which have from time to time been adopted by the Education Department have, of course, impeded Mr. Gadie's efforts, as they have thwarted the good intentions of thousands of teachers.

It is, for instance, a noteworthy fact that Mr. Gadie has, during his career, had his work reported upon by not less than sixteen head inspectors. In spite of cast-iron codes, annual examinations, and many local difficulties, the Park Road Schools have earned a creditable reputation.

During the past three years fifteen of the boys have obtained West Riding County Council Scholarships. A good number have also from time to time won scholarships at the local Grammar School. Many of Mr. Gadie's former pupils hold responsible positions in society, both at home and abroad, as clergymen, sea captains, doctors, bank managers, commercial travellers, etc., whilst some have been members of the School Board in whose service he has so long and so faithfully laboured.

Coming now to the work at Park Road, we notice that the time table is of a varied character. Two class subjects are taken throughout the school, but these are not the same in each class. In Standards I. and II. English is not taken as a subject upon which grant is earned. Occasional lessons in Grammar are given, but a series of object lessons is accepted as an equivalent to the ordinary class subject. Geography is taught throughout the school. Standard III. and upwards take English. In Standards V., VI., and VII. History is taken as a specific subject.

Mr. Gadie is of opinion that the amount of instruction in English Grammar which is required in classes below Standard III. is so small that it is inadvisable to adopt the subject for those classes. Carefully prepared object lessons on interesting topics are far more effective, and considerably less likely to prove irksome.

Registers are marked immediately on assembling, in red ink, and when closed each scholar who has not been punctual receives a black mark. The consequent disgrace acts as a remarkable deterrent, and the punctuality of the children is a feature of the school. Mr. Gadie, although growing grey in the service, still retains his ardent passion for outdoor sport, and he bewails the lack of a suitable cricket ground near his present school, especially as he holds firmly to the conviction that the character of the lads is moulded for good in after life very materially whilst engaged in play. He shakes his head mournfully as he speaks of the early age at which children now leave school. The employment of children of school age he does not think is diminishing, whilst the abstention from school attendance on the part of many children who, whilst they have qualified for half-time exemption as far as the required age and standard are concerned are not 'necessarily and beneficially' employed, is having a

serious effect. Mr. Gadie thinks that the teacher of to-day does not possess the opportunities of influencing the child mind that the pedagogue of twenty years ago enjoyed.

Discussing the present educational outlook, Mr. Gadie welcomes many of the departmental changes, but insists that additions to the curriculum must be made possible by the removal of existing uneducational requirements. The entire abolition of the annual examination, and with it the extermination of the standards, he thinks are near at hand.

Outside his school Mr. Gadie has found wide scope for his energies. He takes an active interest in the work of the St. John Ambulance Association, and is an Honorary Associate of the Order of St. John of Jerusalem in England. This honour was conferred upon him by the Chapter of St. John and Her Majesty the Queen, and we believe Mr. Gadie is the only teacher in an elementary school who possesses the distinction and the decoration. He is an enthusiast in the work, and encourages his pupils to take up the subject.

For several years he has served on the Education Committee of the local Co-operative Society, and at one period acted as Secretary. Since the interchange of deputations between the Co-operative Congress and the N.U.T. took place, he has done much to bring the teachers' influence to bear on the question of co-operative education.

For many years he devoted much labour on behalf of the local Pupil Teachers' Examination Association, and has been able to see the benefits which the Association conferred upon the pupil teachers who came under its influence during its existence. As a Unionist we should require considerably more than our allotted space if we were to chronicle a full record of his work. He has been a member of the N.U.T. since its formation. He is President of the Dewsbury, Batley and District Association, of which organisation he was, over twenty years ago, the founder. Continuously for a score of years has he held some office in connection with this Association. Last year he was President of the local branch of the Teachers' Guild.

His name in West Yorkshire is naturally associated with the teachers' charities. He has been an indefatigable worker for the Orphan Fund, and has raised large sums of money towards its maintenance. He takes a lively interest in the Girls' Orphanage at Sheffield, and has frequently sent useful goods to the home.

He served on the Council of the West Yorkshire District Union in the days before its dissolution, and when the organisation was resuscitated he was unanimously appointed Treasurer, to which position he has been annually re-elected.

The able and exact manner in which he performs what are arduous duties in connection with a large and powerful organisation like the West Yorks District Union, earns for him the gratitude and respect of all who are associated with him.

Mr. Gadie is a striking object lesson to the non-Unionist. Although he is now drawing near the time when he can honourably claim a pension, such as it is, he is active and untiring, and evidently well able to carry out his many duties for some years to come. His unflagging zeal, and his devotion to the work of the Union which has done so much for the cause of education, are remarkable, when one considers the inducements he has to throw off all voluntary work. That he may reap the reward of his long and earnest endeavours, and see many a further advance in educational progress, is the wish of all who have the privilege of his acquaintance.

RECENT EXAMINATION OF A HALF-TIME SCHOOL.

STANDARD I.

Arithmetic.

Addition: 132 + 649 + 517 + 368 + 45 = 1711. Ans.

Subtraction: 217 — 128 = 89. Ans.

Subtraction: 603 — 427 = 176. Ans.

Mental Arithmetic.

6d. + 4d. + 10d. = 1s. 8d.; how much is this less than 2s.? 6×7? 5×9? 3×9? 6×9? 4×9—10? 3×8+10?

Transcription.

'And these, Harry, are the four cardinal points—South, North, East, West.

Geography.

How is a river shown on a map? What do different colours stand for? What does blue stand for? Asked a girl to point out a river. Which is water and which is land? Why do we have different

colours on a map? (To make it look pretty.) Boys drew plan of the school on their slates.

SINGING.

|d:d| d:—|d:—|—:—|

Following Modulator Tests—**d, r, s, f, d, t, d, s, d, r, s, d, r, d¹, r¹, r¹, f¹.**

Ear Tests—**d, r, s, d. d, s d¹, s. d s t, d.** The children sang these to 'Lah.' Three songs also taken.

POETRY.

Twelve children recited individually. Last verse recited altogether. Questions given on meanings of words.

STANDARD II.

ARITHMETIC.

13056 — 9867 = 3189. Ans.

49038 × 169 = 8287422. Ans.

55073 ÷ 8 = 6884 + 1. Ans.

Only 3 sums given B group.

DICTATION (C GROUP).

When the course of a river is very steep, and the water rushes rapidly over its stony bed, it is said to form a rapid.

When such rivers become swollen after much rain they form mountain torrents.

A group—Reading.

MENTAL ARITHMETIC.

Nine 6's? What is the half of 54? 12 sixes? What are 72 pence? 12 nines? 108 pence?

Showed them their reading book with price 8d. marked on. What would 3 such books cost?

If I spent 9½d. what change out of 1s.?

How many 1½d. books can I get for 1s.?

GEOGRAPHY.

Put up map of England before class. Asked for South and West coast. Point out county on West coast? What is that county? (Lancashire.) Where is mouth of Thames? Can you point out its source? Which way does it flow? Into which sea? Any other seas round England? Pointing to North Channel; what is that? Pointed to peninsula in Wigtown, Scotland; what is that? What is the piece of land joining it to Scotland? How is a delta formed? How does the land get down to the mouth of a river to make one? Why are there no deltas in England? There are certain ins and outs round the coast of England; how have they been formed? What do we call them? What is the piece of water between Lizard Point and Land's End?

STANDARD III.

ARITHMETIC.

1. Add together £14,067 18s. 9d. + £742 16s. 10½d. + £89 14s. 7½d. + £9,634 15s. 5d. + £8,763 14s. 9½d.
Ans. £33,299 0s. 5½d.

2. £72,562 15s. 2½d. — £48,917 16s. 5d.
Ans. £23,644 18s. 9½d.

3. Share 80,020 nuts equally among 28 boys and an equal number of girls. Ans. 1428 + 52.

4. A boy sold 160 papers on Monday, 200 on Tuesday, and the same on Wednesday as on Monday. How many will he sell for the rest of the week to make 1,000? Ans. 480.

1. £72 12s. 11d. + £9,627 15s. 6d. + £82 13s. 9d. + £69,273 18s. 7½d. + £9,674 15s. 8d. + 14s. Ans. £88,732 10s. 5½d.

2. £7,069 15s. 0½d. — £6,809 19s. 11d.
Ans. £259 15s. 1½d.

3. Divide 37,052 nuts equally among 37 girls and 120 boys.
Ans. 236.

4. 314 children in a school, and each paid 4d. How many pennies would be collected in 5 weeks? Ans. 6,280d.

Problems.

365 children in a school, and a master collected 2,920d., and each boy brought the same. How much did each boy bring?
Ans. 8d.

A man was travelling in a railway carriage, and bought a 3rd class ticket, he had 12s. 8d. change out of a sovereign. How many miles did he travel at 1d. per mile. Ans. 88 miles.

A man had £1, he had 2s. 8d. change. How many miles did he travel at 1d. per mile. 208 miles.

MENTAL ARITHMETIC.

1. 9 × 25? 5 × 25?
19 × 25? 25 × 25?

2. How many ozs. in 2 lbs.?

3. How many lbs. difference between 1 ton and 19 cwts.?

4. 86 from 250?

5. How many 1½d. books could I get for £5?

6. Take 85 from 165.

DICTATION.

This wise little person one day made up her mind to write a history of her boy's mischievous pranks, and some time or other read it to him. That would be a capital way of making him ashamed of the past, and making him wise and good all at once. So one dark day just before Christmas, the holidays having begun.

GEOGRAPHY.

1. Which railway goes to Holyhead?

2. If I wanted to go from Scotland to Ireland, what railway should I travel by?

3. What fish are like pilchards?

4. What railways pass through Wales, and what part of Wales?

5. Name of a piece of land in Cheshire between mouths of Dee and Mersey?

6. Last place on G. W. Railway in Cornwall?

7. Place in the Isle of Wight where Queen has a house?

8. What watering places on Lancashire coast?

9. Why do people go to Holyhead who want to go to Ireland?

10. Sheet of water between Norfolk and Lincoln?

11. Port on the Humber?

12. Name of sea on South of England?

13. If we went to Wales, flat or mountainous land?

14. Name of chief mountain in Wales?

15. Situation of Yarmouth (fish caught there)?

16. Kind of fish caught round Cornwall and Devon?

17. Where are pilchards caught?

18. Rivers rising in Plinlimmon?

19. Ranges of mountains in Wales?

20. Name of town in Cornwall from which fishing smacks are sent?

21. Rivers in Wales?

22. Name of port sending ships out on Lincolnshire coast?

23. Two seaports in Wales?

24. Railway passing through Nottingham to Bristol?

25. Chief mineral in North Wales?

26. Highest mountain in Cader Idris range?

27. Name of a slate town on Menai Strait?

28. Name of a city in Pembrokeshire?

29. Port opposite Liverpool?

30. Railway from Crewe to Holyhead?

31. Is the coast of Lincolnshire suitable for ports?

32. Name county town of Berkshire where biscuits are made?

33. Name the islands in English Channel near France?

34. Name the sea where the Isle of Man is?

STANDARD IV.

ARITHMETIC.

1. 19s. 7d. × 46. Ans. £45 0s. 10d.

2. 160,978 ounces to tons, cwts., etc.
Ans. 4 tons 9 cwts. 3 qrs. 9 lbs. 2 ozs.

3. 13 yrs. 8 wks. 1 hr. to hrs. Ans. 114,913 hrs.

4. A has 4s. 3d. more than B, B has 2s. 6d. more than C, and C has 3s. 9d. How much have they altogether? Ans. £1 0s. 6d.

1. £76,908 13s. 6d. ÷ 79. Ans. £973 10s. 6½d. + 34.
2. Reduce 12 tons 3 qrs. 13 ozs. to ozs. 431,437 ozs.
3. £395 8s. 7½d. × 84. Ans. £33,216 4s. 6d.
4. A coal dealer bought 35 tons for £35, and paid 3s. for every ton carriage, and sold it for 1s. 3d. per cwt., what did he gain? Ans. £3 10s.
1. £160 17s. 8½d. × 29. Ans. £4,665 13s. 6½d.
2. £710,824 15s. 9d. ÷ 638. Ans. £1,114 2s. 10¾d. + 394.
3. 3 yrs. 38 weeks to days. Ans. 1,358 days.
4. 4 lbs. of tea at 2s. and 4 lbs. at 2s. 6d., mixed and sold at 3s., what was the gain? Ans. 6s.

MENTAL ARITHMETIC.

The teacher questioned class.

DICTATION.

By way of a Christmas dinner, we bought some flour, and raisins, and baking powder, and we made a respectable pudding, but as we had only one pot we had to have the pudding at one, and then we had to cook our meat and have it about four.

In this place there were thousands of wild orange trees in blossom, and the smell was delicious. There were lilies of all colours and very large.

READING.

Unseen from 'School Days.'

GEOGRAPHY.

1. If I post a letter in New York to go to London, how would it come? (Boat to Queenstown, rail to Kingston, boat to Holyhead, and rail by L. & N. W. R. to London.)
2. Why this changing?
3. If a boat left Glasgow to go to Quebec, which way does it go? (Call at Moville and round north of Newfoundland.)
4. All routes from England to Ireland?
5. When do Canadians take their holidays? (Winter.)
6. Why? (Because no work except lumbering.)
7. Cause of fogs round Newfoundland?
8. How wide do you think the Gulf Stream is?
9. How long to go by Canadian Pacific Railway across America?
10. Questions about Red Indians, as to life and where they are now.
11. Freely questioned how Canada was colonized.

The questions covered the whole of England, Scotland, Ireland, as well as Canada.

STANDARD V.

ARITHMETIC.

1. Add together $\frac{1}{2} + \frac{2}{3} + \frac{3}{4} + \frac{5}{6}$. Ans. $2\frac{7}{12}$.
2. 27 acres 3 rds. 20 perches at £1 8s. 8d. per acre. Ans. £39 19s. 1d.
3. If I can get a flock of 80 sheep for £320, how many sheep can I get for £480? Ans. 120.
4. If I exchange 32 gallons of milk for 48 tons of coal at £1 6s. 8d. per ton, how much was the milk per quart? Ans. 10s.
1. A pump lifts 2 gals. 1 qt. 1 pt. at one stroke, and it performs 10 strokes a minute. How long will it be in lifting 2,090 gallons? Ans. 88 min.
2. 5 tons 6 cwts. 28 lbs. at £1 10s. 6d. per ton. Ans. £8 2s. 0½d.
3. Reduce 708,608 sq. ft. to acres, etc. Ans. 16 acres 1 rd. 2 sq. pls. 23½ sq. yds. 2 sq. ft.
4. If 70 men build a wall in 35 days, how long will it take 30 men to complete it? Ans. 81⅔ days.

COMPOSITION.

'The Pilferer Caught.

'A mother, being very busy in the kitchen, asked her little girl to go to the pantry and bring her some apples. Now this little girl was fond of jam, which her mother kept in a large jar on the shelf. Thinking she would like to taste the jam, she stood on her toes and put her finger into the jar. Suddenly a lobster, that was in the jar, seized her hand, and she began to cry out loudly. Some days before, her mother had emptied the jam into smaller jars, and this large jar being empty she had put a large lobster into it. The little girl was much ashamed when her mother came into the pantry to release her.'

STANDARDS V. AND VI.

HISTORY.

What do you mean by a colony? Name of great judge who lived in the reign of James I.? Questioned on the life of Lord Bacon. Colonies founded by Raleigh? Offices held by Bacon? Object of East India Company? Questioned upon the Pilgrim Fathers. Questioned fully upon the life of Oliver Cromwell. Name some of his greatest victories? Name of his soldiers? (Ironsides.) The teacher questioned fully upon the Trial of the Seven Bishops. Why was Sept. 3rd remarkable in Cromwell's career?

STANDARD VI.

ARITHMETIC.

Add $\frac{5}{8}$ of £1 + $\frac{4}{7}$ of 1s. + $\frac{5}{84}$ of 1d. Ans. 11s. 8½d.

If a train travelled $41\frac{8}{11}$ miles in $\frac{20\frac{1}{2}}{9}$ hours, how far will it travel in 22 hours? Ans. 408 miles.

If I build a house with £2,572 10s., and out of that I got £105 as rent, and I had to pay £2 2s. expenses, what was the rate of interest I received on my outlay? Ans. 4 per cent.

Reduce $\frac{7009}{16380}$ to its lowest terms, and convert your answer into a decimal. Ans. (*a*) $\frac{13}{30}$; (*b*) ·43.

Take ·01 from ·01, and divide it by ·06. Ans. $\frac{1}{6}$ or ·01$\dot{6}$.

If the rate of interest be £4 10s., what will be the interest of £999 for 15 years? Ans. £674 6s. 6d.

If a bicycle goes $7\frac{1}{2}$ miles an hour, how long will it take it to go the same distance as a coach, going for 12 hours at $7\frac{2}{3}$ miles per hour? Ans. $11\frac{5}{23}$ hrs.

A tried to do $\frac{3}{4}$ of 24 sums set at an examination, and $\frac{2}{3}$ of the number he attempts are right. B's correct answers were $\frac{1}{4}$ more than A's, and C's $\frac{1}{5}$ more than B's. What proportion of C's sums are right? Ans. 18 sums or $\frac{3}{4}$.

COMPOSITION.

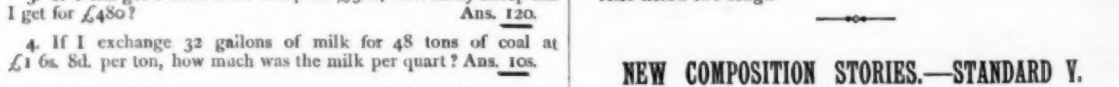
1. Foreign Possessions.
2. Tame animals.
3. Week's work at school.
4. Boys' weekly papers.

STANDARDS V. AND VI.

READING.

Unseen. From 'Hereward the Wake.'

MUSIC.



Also heard two songs.

NEW COMPOSITION STORIES.—STANDARD V.

Suitable for 'Unseen Tests' in Reading also.

279.

PROFESSOR BLACKIE AND THE BOY.—Professor Blackie was one day lecturing to a new class. In answer to some direction given by the professor, a student rose to read a paragraph, his book in his left hand. 'Sir,' thundered Blackie, 'hold your book in your right hand!'—and as the student would have spoken—'No words, sir! Your right hand, I say!' The student held up his right arm, ending piteously at the end of the wrist. Before the doctor could open his lips there arose a perfect storm of hisses. Then the professor left his place, and went down to the student he had unwittingly hurt. He put his arms round the lad's shoulder, and drew him to his side. 'My boy,' said the professor—he spoke very softly, but every word

was audible in the hush that had fallen in the class-room—'My boy, you'll forgive me that I was over rough? I did not know—I did not know.' He turned to the students, and with a look and tone that came straight from his heart, he said, 'And let me say to you all, I am rejoiced to be shown that I am teaching a class of gentlemen!'

280.

How the Revenue was Cheated.—Everything that enters Paris has to pay duty. For many weeks, an elegantly attired gentleman drove a well-appointed dog-cart from the outskirts to the city, being attended every evening by a neat-looking groom. One night the dog-cart was upset in the presence of the police, who, on going to the rescue, noticed that the groom had not moved from his seat. 'Come,' said one of the men. The groom preserved a dignified silence. 'Come down,' cried they angrily. 'Don't you see that your master is hurt? Are you drunk or stupid?' The police, on giving him a shake, discovered, to their unutterable astonishment, that he was made of zinc, and contained one hundred and fifty bottles of brandy.

281.

The way the Division was made.—Three gentlemen ordering a supper at a tavern, one of them wished for a partridge; a brace were brought, and he who had ordered them was requested to divide them; which he accordingly did, by taking one to his own plate, and leaving the other for his friends. 'Stop,' cried one of them, 'this is an unequal division!' 'Not so,' replied he, 'there is one for you two, and one for me *too*.'

282.

How the Thief Escaped.—A notorious East Indian thief, was asked to explain how he managed to carry off a horse when hitched by all four feet to posts, as is the custom in India, and with men lying around. Would he give a specimen of his skill? 'Willingly.' With the consent of the magistrate, who was present on the occasion, he was taken from the gaol to the officer's house, where a restive horse was hobbled as described; men were ordered to lie down in a circle round it. 'Now,' said the colonel, 'could you take the horse without touching these men?' 'Easily.' 'Do so, then.' The prisoner urged that, encumbered with fetters, the attempt would fail; and, as this assertion seemed reasonable, they were removed. Stepping over the circle of men he caressed and unbound the horse; then gently lifting a fore-foot advanced it a step. Obedient to his hand, the horse permitted each foot to be lifted and placed in turn. They were on the edge of the circle, when, quicker than thought, the thief bounded on the back of the horse, and before the astonished spectators could utter a word, he was off and away.

283.

Obedience.—During the continued shocks of an earthquake which destroyed a little Russian village not long since, there stood a private soldier who had been stationed at that point, and directed not to move until ordered to do so. Buildings all about him were trembling and falling, but he stood motionless, his hands upraised as if in prayer. Not a moment too soon to save the soldier's life, an officer, dashing by, saw him, took in the situation, and shouted his order to 'Move on.' The soldier gladly obeyed. The Emperor of Russia hearing of it rewarded the man for his obedience.

284.

The Eagle and the Jackdaw.—An eagle whose eaglets were very hungry, swooped down from his eyrie upon the plain below, and carried off a lamb in his talons. A jackdaw, seeing him do this, thought he would do as much, or even more. So he flew round and round, making a great noise with his wings, and at length alighted on the back of a large ewe, for the purpose of carrying her off. But his claws got entangled in the wool, and so far from carrying off the sheep he could not even get away himself. There he stood miserably cawing, chattering, and struggling on the ewe's back, until he was caught by the shepherd when he came round. The shepherd clipped his wings and took him home to his children. They asked what kind of bird it was. The shepherd answered 'He is really a jackdaw; but I found him trying to pass himself off for an eagle.'

285.

The Drunkard and the Monkeys.—A rich drunkard kept two monkeys for his sport. One day he looked into his dining-room where he and his guests had left some wine, and the two had mounted the table, and were helping themselves generously to the wine—jabbering and gesturing, as they had seen their master and his guests. In a little time they exhibited all the appearance of drunken men. First they were merry and jumped about, but soon got to fighting on the floor, and tearing out one another's hair. The drunkard stood in amazement. 'What!' said he, 'is this a picture of myself? Do the brutes rebuke me?' It so affected his mind, that he resolved he would never drink another drop. And from that day he was never known to be any other than a sober and a happy man.

286.

An Omission Rectified.—A little boy was ailing from some trifling childish complaint, which necessitated him taking medicine; he had just received his daily dose, when his mother said, with some excitement: 'I quite forgot to shake that bottle before giving it to you, Johnnie. Come here.' Johnnie obeyed, and much to his astonishment and disgust, was subjected to a vigorous shaking from the strong arms of the parent, at the conclusion of which he was laid down with the remark: 'There, my laddie, that'll do. It should be well mixed up now, I'm thinking; but don't let me forget again.' Johnnie promised.

287.

A Piece of Impudence.—A celebrated professor was lecturing one day before the students on geology. He had before him a number of specimens of various sorts to illustrate the subject, when a roguish student, for the sport, slily slipped a piece of brick among the stones. The professor was taking up these one after the other, and naming them. 'This,' he said, 'is a piece of marble; this is granite,' and so on, Presently he came to the brickbat. Without betraying any surprise or even changing his voice: 'This,' he said, holding it up, 'is a piece of impudence.'

288.

A Narrow Escape.—An Irish farmer who had been much annoyed by thieves, who came and robbed his garden, was locking up for the night when he saw a dark figure in the middle of his garden. Picking up a big stone, he hurled it with all his force at its head, and then, being frightened, went in, and went to bed. The next morning, on going out, he found to his astonishment that he had knocked over his own hat, which he had stuck upon a pole the day before to scare away the birds. He uttered a loud exclamation of joy, at which his wife called out to ask at what he was so pleased. 'A great deal I have to be pleased over,' said he, 'for last night I threw a stone big enough to split a man's head open at my hat here in the garden, and is it not fortunate that I was not wearing it at the time, for if I had, I should be a dead man now, and you, my dear, would be a poor widow.'

289.

Very Choice!—A good story is told of a lady who, on her way to an evening party, purchased a most unbecoming yellow turban, which caused her to be for some time an object of merriment to the whole room, owing to the fact of the shopkeeper from whom she had bought it having forgotten to remove from behind it a large ticket bearing the printed inscription: 'Very choice. Only 6s. 11½d.'

290.

A Brave Miner.—A fire once broke out in a coal-mine in America, whereupon the miners, in a panic, rushed to the cage, each struggling for a place. The foreman, a strong cool-headed man, took in the situation at a glance. Pushing them all aside, he called out as many as could be hoisted at one journey, and in doing so he selected first those who had large families dependent on them, then those who had fewer relatives, then husbands who had no children, then unmarried men. The fifth and last lift conveyed the worthless characters and the foreman, the fire scorching their clothes. When praised for his conduct, he carelessly replied, 'Oh, that was nothing. If I hadn't got those fellows out of the way I should have been burned up, don't you see.' Such was the modest answer of the hero.

291.

A Knowing Dog.—A well-known gentleman has a beautiful St. Bernard dog, which is devoted to his master, and seems to have been blessed with an unusual amount of sagacity even for a St. Bernard. It chanced one day that he left the dog in the smoking-room of a Liverpool hotel while he himself went to get some lunch. Annoyed at his master's absence, the dog determined to go and look after him. But the door was shut. Then Lion sat down and argued the situation out. 'When my master wants anything,' he must have said to himself, 'he pushes that little knob by the fire-place and he gets it. Wonder if I shall.' At all events the experiment was worth trying, and, putting his great paw on the button, he rang the electric bell. When the waiter opened the door he marched majestically out.

292.

Why it Dragged on.—Last winter the roof of a gentleman's house was so damaged by the snow that he was obliged to send, when spring came, for the slater to repair it. Three men and a boy

came and set to work. With so large a force employed it was to be expected that the job would be completed in a day or two. But a week dragged on and still the three men and the boy kept making their appearance every morning. And yet they seemed to work hard, too; for the noise of hammering on the roof resounded through the house from morn till night. At last the owner of the house determined to see for himself how things were proceeding. Accordingly he crept up through the skylight. A strange sight met his eyes. The three men were comfortably sheltered behind the chimney stack, smoking and playing cards, whilst one of them called out to the boy, who was busy with a hammer in each hand rapping on the slates, 'If you don't make more row than that, you young beggar, they'll think we're doing no work!'

293.

SALLY LUNN CAKES.—These cakes owe their origin to a young woman named Sally Lunn, who lived at Bath at the beginning of the present century. It is said that she cried them through the streets of the city, with a white cloth over her basket, every morning and evening, until at length a respectable baker, who was also a musician, having noticed her, not only purchased her business, but wrote a song about the cakes, set it to music, and sold it for the benefit of Sally Lunn. The music became such a favourite, and so increased the popularity of the cakes, that barrows had to be provided to distribute them, until eventually the baker retired with a fortune, and Sally Lunn cakes became known through the country.

294.

TOMMY'S MISTAKE.—Tommy was a very bad boy, whom his mother had hard work to manage. The granary in the farm-yard was raised a few feet from the ground, and Tommy, to escape a well-deserved thrashing, ran from his mother and hid under the structure. Presently his father came home, and, hearing where the boy had taken refuge, went and crept under the granary to bring him out. As he approached on his hands and knees, Tommy said: 'Is she after you too, father?' But Tommy soon found he had made a mistake for once.

295.

A CURIOUS COMBAT.—A traveller in South Africa was musing one morning, with his eyes on the ground, when he noticed a caterpillar crawling along at a rapid pace. Pursuing him was a host of small ants. Being quicker in their movements, the ants would catch up with the caterpillar, and one would mount his back and bite him. Pausing, the caterpillar would turn his head, and bite and kill his tormentor. After slaughtering a dozen or more of his persecutors, the caterpillar showed signs of fatigue. The ants made a combined attack. Betaking himself to a stalk of grass, the caterpillar climbed up tail first, followed by the ants. As one approached, he seized it in his jaws and threw it off the stalk. The ants, seeing that the caterpillar had too strong a position for them to overcome, resorted to strategy. They began sawing through the grass-stalk. In a few moments the stalk fell, and hundreds of ants pounced upon the caterpillar. He was killed at once, and the victors marched off in triumph, leaving the foe's body on the field.

COMPOSITION TESTS.—STANDARDS V.—VII. AND 1ST & 2ND YEAR P.T.'S.

Write at least 25 lines on ONE of the following:

20. Write what you can about obedience, what you mean by it, whom to obey, why and how you should do so, effects of obedience, etc.; OR

21. Say all you can about the importance of speaking and acting the truth, its meaning, necessity, benefits, etc.; OR

22. Write all you can about good manners, their importance, etc., why they should be acquired and practised; OR

23. Tell me what you can about sleep, what is it, why necessary, proper time and why, etc.; OR

24. Write what you can about the advantages of order and method; OR

25. Say all you can about the little trials and pleasures of your life; OR

26. Write all you can about precept and example, referring especially to the influence of your example upon children younger than yourself; OR

27. Say all you can about courtesy and good manners, meaning, etc.; OR

28. Write what you can about frugality or thrift, meaning, habits, blessings, and effects, etc.; OR

29. Say what you can about patience, what it is, how and when exercised, especially in dealing with children, etc. Show the truth of the proverb, 'A continual dropping weareth away stones'; OR

30. Write what you can about honesty, meaning, forms and causes of dishonesty. Prove that 'Honesty is the best policy'; OR

31. Say all you can about happiness at home, how people seek it. Show that outside things cannot give true happiness, but that it depends upon ourselves.

NEW READING TESTS.—STANDARD III.

Suitable for 'Unseen Tests' in Dictation also.

219.—A little fellow was sitting on the floor busy with his toys, hammering away, and making a great noise. His mother said to him: 'Will you please stop that knocking, Frank?' He stopped for a few minutes, and then began again. For the second time he was asked to stop that knocking, and so on for the third time, when the little fellow looked up and said: 'It's not that knocking, mother; it's another.'

220.—We have seen many times during the winter large lumps of ice floating on the top of the liquid water of rivers, lakes, streamlets, and ponds. By floating it tells us that this fixed water is lighter than the liquid water, or that water when frozen is lighter than the same bulk of liquid water. It seems hard to believe at first that a hard solid substance like ice is really lighter than water.

221.—The late Dean Hook was a very plain man—not unlike a bear—and one day he took a little girl on his knee, and, seeing how intently she was watching his face, he asked kindly: "Well, dear, what is it? Have you ever seen me before?' 'Yes.' 'And when was it?' 'It was on Monday, you were on top of a pole, and I gave you a bun!'

222.—A London carpenter for a long time constantly found his oil bottle emptied of its contents. Various plans were devised to find out the thief, but they all failed. At last the man determined to watch. Through a hole in the door he peeped for some time. By-and-bye he heard a gentle noise. Something was creeping up the bench. It was a fine rat. Planting itself on the edge of a shelf, the ingenious creature popped its tail inside the bottle, then drew it out and licked off the oil. This he continued to do until nearly every drop of oil was taken from the bottle.

223.—In a small village some time ago, an old man, taking tea with some friends, saw for the first time a pair of sugar-tongs. Not knowing for what object they were put on the basin, he asked his host, who of course told him. 'And handy things they are,' said the old fellow, as he took a lump of sugar with his fingers, clasped the tongs on it carefully, and dropped it into his cup.

224.—Blackbirds are very nice pets, and may be taught to whistle several tunes. They are not very particular as to what they eat, and are usually fed on paste and meal-worms. The same may be said about the feeding of the thrush. Both these birds are fond of soft hay in the bottom of their cages.

225.—A mother and her children were seated round the tea-table awaiting the father's return from work. At seven o'clock he came in tired and hungry. In the course of conversation with his wife, he was telling her how hard he had to work to keep the wolf from the door. After a time there

was a knock. The mother said, 'Who's there?' when little Freddy (aged six) said: 'Don't go, mother. Perhaps it's the wolf.'

226.—Canaries ought to have plenty of fresh air, and the cage should be sometimes hung in the sun, if not too hot, care being taken that the sunshine does not stream too directly over their heads. A bath is a great luxury, and it should be given once every day in fine weather. Any shallow vessel, such as a saucer, does very well for this purpose.

227.—At a small town in Ireland a gentleman employed a carpenter to put up a partition, and had it filled with sawdust to deaden the sound. When it was completed, the gentleman called from one side to the carpenter on the other, 'Smith, can you hear me?' Smith immediately answered, 'No, sir.'

228. How doth the little busy bee
Improve each shining hour;
And gather honey all the day
From every opening flower.
How skilfully she builds her cell,
How neat she spreads her wax;
And labours hard to store it well,
With the sweet food she makes.

NEW DICTATION TESTS.—STANDARD IV.

Suitable for 'Unseen Tests' in Reading also.

No. 166.

CALIFORNIA carries on a large business in sea-shells, which are gathered on its coast and shipped to Europe. One firm has a contract to ship forty tons of shells every sixty days. They are worth from a hundred and forty to two hundred pounds a ton. They are used in all kinds of decorative industries, returning to the United States from France, vastly increased in price when transformed into pearl buttons, brooches, shawl-clasps, knife-handles, or turned to account for various descriptions of inlaid work.

No. 167.

IF fish are taken alive out from below the ice, in lake or river, during an intense frost and thrown upon the ice, or among the snow, so as to freeze immediately, although they are seemingly dead, and so stiff as to break short upon trying to bend them, yet you may bring them to life again, or rather back to a state in which they will perform all their animal functions, as perfectly as before they were frozen—the fact is, they are not dead, but the functions of life are only suspended.

No. 168.

THE custom of eating goose on Michaelmas-day is said to have originated with Queen Elizabeth. Being on a visit to one of our sea-ports when our fleet had gone to oppose the Spanish Armada, just as she had one day sat down to dinner, of which a goose formed a part, news was brought to her of the total defeat of the enemy. Her Majesty immediately ordered that the dish then before her might be served up on every 29th day of September, in commemoration of such a glorious event.

No. 169.

IN a Birmingham wine-room is placed a very sensible notice, which sets forth that gentlemen who wish to swear, or indulge in bad language, to the annoyance of respectable customers, are requested to ask to be shown to an apartment specially provided for the use of blasphemously-disposed individuals. Should any offender be bold enough to inquire his way to this sanctum, he is politely conducted by a boy in buttons to the front door, the 'apartment specially provided' being in fact the open street.

No. 170.

IT has been remarked that dogs turn around several times before lying down. The habit is supposed to point to the time in canine history when the dog was wild, and inhabited jungles or tall grass. Then it was necessary to turn several times in order to twist the grass into the proper position for pressing down into a comfortable nest. The habit became fixed, and the modern dog has not outgrown it.

No. 171.

THE Chinaman can write all day, he can work all day, he can stand for a whole day in one position, weaving, hammering gold, or cutting ivory, without once being attacked by nervousness. This peculiarity makes itself apparent in early youth. He can bear any kind of bodily exercise. Sport and play are to him unnecessary labour. He can sleep anywhere and in any position—amid thundering machines, deafening noises, the cry of children, or the wrangle of grown people; on the ground, in bed, or on a chair.

No. 172.

THE Bank of England note is not of the same thickness all through. The paper is thicker in the left-hand corner to enable it to take better and sharper impression of the vignette there, and is also considerably thicker in the dark shadows of the centre letters and under the figures at the ends. Counterfeit notes are invariably of one thickness.

No. 173.

ONE of the ancient customs connected with Swedish funerals was to place a small looking-glass in the coffin of an unmarried female, so that when the last trumpet sounds she might be able to arrange her tresses. It was the practice for Scandinavian maidens to wear their hair flowing loosely, while the matrons wore it bound about the head and generally covered with some form of cap. Hence the unmarried woman was imagined as awakening at the judgment day with more untidy locks than her wedded sisters, and more in need of a looking-glass.

No. 174.

RAILROAD conductors get a great deal of medical information and the understanding of many helpful little schemes in the course of a long year's run. Many of the conductors, who, among the many other ills and ailings of their passengers, have found a particle of dirt or cinder in the eye to be the most frequent and painful, carry with them a supply of horse-hair. Their experience makes them experts in doubling the hair and drawing it over the eye while the lid is closed.

No. 175.

PIGEONS are only surpassed in their speed by the humming-bird, which, glancing through the air with the velocity of a meteor, flies swifter than any bird in creation; and for powers of long-sustained flight the pigeon is exceeded only by oceanic birds. But for combined speed and sustentation of flight the pigeon has no equal; an instance having been recorded of one which travelled seventy-two miles in two hours and a half.

No. 176.

Earth's joys are but a dream; its destiny
Is but decay and death. Its fairest form
Sunshine and shadow mix'd. Its brightest day
A rainbow braided on the wreaths of storm.
Yet there is blessedness that changeth not;
A rest with God, a life that cannot die;
A better portion, and a brighter lot,
A home with Christ, a heritage on high.

STANDARDS V.—VII., AND 1ST & 2ND YEAR P.T's.

No. 152.

THE nutmeg is the innermost kernel of the fruit of a small tree that grows about thirty feet high. It is a native of the East Indies, but it is cultivated in other tropical lands. It has a small yellow flower. The fruit is small and peach-like, but with a smooth surface, and turns yellow when ripe. The exterior, a thick fleshy husk, dries up and cracks, disclosing the nut. The outer covering of this nut is what we know as mace. It is red at first, but turns to a light brown when dried. Next comes a hard shining shell, and inside that is the nutmeg. The tree bears about the eighth or ninth year. The mace is taken off and dried in the sun for one day, and for eight days in the shade, then dampened with sea-water and pressed in bags. The remainder of the nut is very thoroughly dried, when the shell is broken and the nutmegs are assorted, the best ones being exported.

No. 153.

AN old home acquires power over the heart with course of time; it comes by degrees to touch the imagination with a sense of life inherent in itself. Its timbers are not dead wood. As the vibrations

of the music constrain the fibres of the violin till, year by year, it gives forth a fuller and deeper tone, so the vibrations of life, as generations go by, shape the walls of a home into a responsive accord with the human experience that goes on within them. Birth and death, joy and sorrow, hope and disappointment—all that men endure and enjoy, give to it a constantly increasing sanctity and a power to affect the hearts of those who dwell within it. Memory awakens imagination. Each generation has set its lamp upon the home in some change, some improvement. The lapse of years makes it venerable, and the older it is the sweeter and richer garden does it become of human charities and affections.

No. 154.

SUDDEN changes in the temperature from heat to cold put a good deal of money in the pockets of opticians, for they often cause the glass in spectacles to crack, as if trodden upon. They also have a bad effect upon the frames, and wearers of aids to the eyesight are often startled by having their spectacle frames suddenly fall apart at the bridge. A man accustomed to wearing glasses is utterly lost without them; he becomes dizzy after a short time, experiences nausea, and suffers any number of inconveniences. Of course the minute his glasses break he rushes off to the nearest optician.

No. 155.

THE evenings of great numbers of families are monotonous humdrum. They involve the assemblage of the same people, the same surroundings, the same paterfamilias yawning over his paper, the same querulous mamma overladen with family cares. Fresh people with fresh thoughts, fresh atmosphere, anything to stir up and agitate the pool of domestic stagnation, are sadly needed and sadly scarce. There needs to be also a constant succession of such fresh people to bring about these results. The world is full of men and women, and in a better regulated life it would be the business after the day's work was done to entertain each other, and give each other fresh life. As it is now, hundreds if not thousands of our households are little better than cells for the incarceration of each family. Thousands are thus worn out prematurely from utter lack of domestic recreation. There might be written over the graves of hundreds of thousands, 'Bored to death by the stagnation of domestic life.'

No. 156.

QUEEN VICTORIA is never seen to lose her temper with her inferiors, but servants know that household arrangements must go as by clock-work, or the Royal lady speedily knows the reason why. As a rule, she calls them by their Christian names, and encourages them to speak freely to her and not to stand in too much awe of her. She always inquires their names when they first come to the palace, and, despite the immense size of her household, she never forgets any of these names. She is a kind mistress and much beloved by the domestic staff.

No. 157.

ONE of the most beneficial features of a sea-bath, says a medical practitioner, is the salt water inadvertently swallowed by bathers. It is a wonderful tonic for the liver, stomach, and kidneys. In many cases it will cure biliousness, where all drug preparations have failed. It is peculiarly effective in ordinary cases of indigestion, disordered stomach, and insomnia, and has been known to produce excellent results in many cases of dyspepsia. Sea-water is full of tonic and sedative properties. It won't hurt anybody. Two or three big swallows of it would be of positive benefit to nine bathers out of ten. It isn't palatable or tempting, but neither is quinine or calomel.

No. 158.

PARROTS have long been taught to amuse by their imitation of the human voice, and now their powers in this respect have been made use of for a practical purpose. At almost every station on a German railway the station-master has a parrot or a starling so trained, that whenever a train draws up at the platform, it commences calling out the name of the station most distinctly, and not only this but it continues doing so while the train remains there. This has been found an excellent mode of informing the passengers where they are. An importation of these novel railway porters is much needed at English stations.

No. 159.

ONE thousand two hundred sheets of the thinnest tissue paper measure a slight fraction over an inch in thickness, while sheets of iron have been rolled to an average thickness, or thinness, of the eighteen-hundredth part of an inch; in other words, one thousand eight hundred sheets of this iron, piled one upon another, would measure only an inch in thickness. These wonderful iron sheets are perfectly smooth, and easy to write on, notwithstanding the fact of their being porous when held up to a strong light. This is a result of the competition which has long been carried on amongst ironmasters, as to the degree of thinness to which iron can be rolled.

No. 160.

THE custom of lifting the hat had its origin during the age of chivalry, when it was customary for knights never to appear in public except in full armour. It became a custom, however, for a knight, upon entering an assembly of friends, to remove his helmet, signifying 'I am safe in the presence of friends.' The age of chivalry passed away with the fifteenth century, but among the many acts of courtesy which can be traced back to its influence none is more direct in its origin than that of lifting the hat to acknowledge the presence of a friend.

No. 161.

THE lucky man enjoys the pleasures of anticipation, which are far keener than those of fruition. He achieves success after success, and each of his victories is preceded by a period of pleasurable hope. Every attainment has the charm of novelty, and is followed by the delight excited by the sympathy and admiration of friends. The man who is born rich possesses the means of satisfying numerous appetites and desires, but these gratifications are obtained without effort, and the relish for them soon grows comparatively languid. Even if the lucky man gets his good things without exertion, the novelty and surprise of his windfalls are most pleasurable. The happiest men are those who fight their way to success.

No. 162.

O THOU sweet Lark, who in the heaven so high
Twinkling thy wings dost sing so joyfully,
I watch thee soaring with a deep delight,
And when at last I turn my aching eye
That lays below thee in the Infinite,
Still in my heart receive thy melody.—
O thou sweet Lark, that I had wings like thee!
Not for the joy it were in yon blue light
Upward to mount, and from my heavenly height
Gaze on the creeping multitude below:
But that I soon would wing my eager flight
To that loved home where Fancy even now
Hath fled, and Hope looks onward through a tear,
Counting the weary hours that hold her here.

OUR PUPIL TEACHERS' COURSE.

BY GEORGE COLLAR, B.A., B.SC.,
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THE New Code (1895) has brought few changes that affect pupil teachers, but such as they are they must be noted. In the first place 'the engagement of a pupil teacher can only begin either on the 1st July or on the 1st January'; but this rule will not come into force before June 30th, 1896, and until then the engagement of a pupil teacher may begin at the beginning of the school year.

In future the poetry selected for recitation must be *standard* poetry, and the following are given as examples:—

First Year.—(50 lines) Gray's 'Bard,' and 'On a distant Prospect of Eton College.'

Second Year.—(80 lines) Goldsmith's 'The Traveller,' or Cowper's 'Morning Walk.'

Third Year.—Pope's 'Essay on Man,' Epistle I., or Milton's 'Samson Agonistes.'

A knowledge of the meanings and allusions is required as before, and it is now definitely stated that, 'A knowledge of the subject matter of the selected book and of the history of the author and his times will be required.' This knowledge was always acquired by those pupil teachers who prepared their recitation intelligently; but now it is clearly indicated that no pieces will be accepted which have not been thoroughly well prepared. In order to encourage a more detailed study of the structure of the poem, 'in all cases the exercises in parsing, analysis, and paraphrase are to be taken from the books selected for the recitation.'

This is a decided gain as regards the paraphrase and etymology; but as parsing and analysis are subjects requiring the application of certain general principles, and not the reproduction of something stored in the memory, it should be as easy to parse and analyse an unseen passage as a familiar one. With regard to paraphrase, we cannot help thinking that, at any rate up to the present, the exercises

in paraphrasing have been set with quite a wrong object in view. As a test of the pupil teacher's powers of composition they are most unfair, for how can a pupil teacher show his powers in this direction, when called upon in the hurry of an examination to paraphrase a passage which one of our greatest poets perhaps had spent hours over in order to express his thoughts in the clearest and most beautiful language. It is now to be hoped that paraphrase will be confined to what is its only legitimate use in an examination, viz., to determine whether the student understands the meaning of the poem he has been reading, by calling upon him to give the meaning in his own words of short passages and phrases.

One difficulty naturally presents itself at this point, namely, that the poems named under the head of Recitation are not put down as compulsory, but only as indicating the *class* of poem that is required, while the department pledges itself to set the Grammar questions on those individual pieces. All pupil teachers are therefore advised to take for their recitation the pieces actually named.

In the Code of 1894, considerable changes were introduced into the History and Geography syllabus, not only were the sections recast, but Division I. was allotted to all years for 1895, Division II. for all years for 1896, and Divison III. for all years for 1897. This change was made in the interest of those pupil teachers who receive instruction from their own head teacher, who frequently has to instruct three or four pupil teachers in as many different years. It has been pointed out that this not only necessitated a great deal of repetition for those who have already passed their 1st Year, but it makes the work of teachers at pupil teachers' schools very monotonous, for the history lecturer would perhaps have to give the same lessons a dozen times to different sets of pupil teachers. This difficulty has been obviated by a note which says :—'Pupil teachers taught at centres may, with the special leave of the Department, be examined in the first year of their engagement in the 1st Division, in the second year in the 2nd Division, and in the third year in the 3rd Division.'

In the 2nd Division the syllabus now reads, 'Europe and Asia *with special reference to* British India,' instead of merely, '*including* British India.' Moreover, as there was some difference of opinion as to whether 'Polynesia' included Australasia, the syllabus now specifies 'Australasia and Polynesia.'

The Scholarship Syllabus now disappears from the Code, but will be forwarded to intending candidates who apply to the Secretary, Education Department, Whitehall, S.W. (Letters may be marked 'Queen's Scholarship Syllabus,' outside).

Some important changes have been introduced into the syllabus this year. In the first place the scale of marks has been altered, thus :—

	1895.	1894.
Reading	60	45
Repetition	40	45
Algebra and Mensuration	80	90
Euclid	80	70
School Management	80	60
Needlework	80	100
Music (theory)	20	30
,, (practical)	30	20
Language	70	60

Composition has been separated from Grammar and carries 30 marks, while the Grammar paper alone carries 70, the number formerly assigned to Grammar and Composition. The number of marks for the other subjects remains unaltered.

It is gratifying to see that with the institution of a separate mark for Composition, in which the candidate is required 'to write simple prose upon a given subject,' paraphrase disappears from the syllabus. The outline of the history of English language and literature, which was omitted for last December, is now compulsory.

Those who take Latin as an alternative for English Grammar will be pleased to see Cæsar 'De Bello Gallico,' Book II., Chaps. 1 to 19, set; they have already made its acquaintance in their third year, though perhaps many would have preferred something fresh.

An important innovation appears in the Arithmetic for Women. Not only will alternative questions be set in Algebra, but those questions will be more highly marked than the questions in Arithmetic for which they are substituted. Those who followed our advice last September and began the study of this easy and interesting subject will now be congratulating themselves. It is not too late to begin now. The work is more than covered by Hall and Knight's 'Algebra for Beginners,' Macmillan, 2s. 6d.; or Harvey's 'Easy Steps in Elementary Algebra,' Hughes, 6d.

The Geography is limited to that of the British Empire, and the maps to the British Islands, France, and Italy.

The History ranges from 1066 to 1603, with a special knowledge of the reign of Elizabeth.

The second question in Section IV. of the recent Domestic Economy paper shows that 'Thrift' was meant to be included in last year's syllabus, and was only omitted by an oversight. It appears this year.

This part of the subject is most ably dealt with by Mrs. Burgwin in Hughes' 'Domestic Economy.' Another useful book on this subject is Bartley's 'Provident Knowledge Papers'—Chapman and Hall, 1s.

In the Languages syllabus, those who have been preparing candidates for Scholarship for the last few years will welcome the changes made in the authors set. Our old friends 'La Jeune Sibérienne,' and Cæsar, Book I., give place to Coppée's 'Le Trésor,' and Cæsar, Book V., chaps. 8 to 37.

The same books will be taken in 1896.

With the object of making the science teaching more practical, additional marks are to be given when Practical Chemistry is taken with Theoretical.

We have insisted on the necessity of keeping Saturday afternoon free for recreation and physical exercise. The instructions to H.M. Inspectors also point out the necessity of this, and it is emphatically laid down that '*in the case of pupil teachers attending central classes on Saturdays, attendance in the afternoon as well as in the morning cannot be permitted, unless the managers allow one half-holiday at least on some other day of the week. Two half-holidays, however, would be desirable.*'

Scheme of Work for the Month.

A.—*English.*

(i.) *First Year.*

The Verb.—Three independent classifications (*a*) according to meaning—Transitive and Intransitive; (*b*) according to Conjugation, Anomalous, Strong and Weak; (*c*) Principal and Auxiliary. Voice, Mood, Tense, Person, and Number. See Daniel, 62–110; Beach, 53–78; Morris, 49–81.

Life of Gray.

(ii.) *Second Year.*

Classification and use of Adverb, Conjunction, and Preposition.

Life of Oliver Goldsmith.—'The Traveller,' to be carefully read through, noting the following points:—Circumstances under which the poem was written; its object; allusions, especially personal allusions; exact meaning of each word and phrase.

(iii.) *Third Year.*

Revision of prefixes and affixes.

Life of Milton:—'Samson Agonistes.' This poem is very deep and requires very careful study, but it well repays the labour spent on it. It was called a 'Dramatic Poem' by Milton, probably because he was afraid that if he called it a Drama or Play he might offend some of his Puritan friends. The student will be able to learn from this the regular structure of Greek plays, on the model of which 'Samson Agonistes' has been constructed, particularly in the observance of the 'three unities' and in the employment of a 'chorus' to describe events which cannot well be shown on the stage. The work should therefore be read carefully right through, attention being paid to the meaning of difficult words and sentences. The latter are frequently very involved. It will be noticed that, although there is no division into acts and scenes, the play is easily divisible into sections, and the student should revise the introductory portion (lines 1–325); if time admits, the next episode (conversation with Manoah) may be included.

B.—*Arithmetic.*

(i.) *First Year.—Boys.*—Application of Vulgar Fractions to concrete quantities. Finding a given fraction of a quantity, and reducing one quantity to the fraction of another.

Girls.—Reduction of Vulgar Fractions to a Common Denominator. Addition and Subtraction of Vulgar Fractions.

(ii.) *Second Year.—Boys.*—Simple Interest. To find either Interest, Amount, Time, Principal, or Rate per cent., when any three of the other terms are given.

Girls.—Same as First Year Boys.

(iii.) *Third Year.—Boys.*—Revision of Decimal Fractions, particular attention being paid to the theory and proofs of rules. Work miscellaneous examples in Decimals.

Girls.—Application of Decimals to Concrete quantities. Reduction of one quantity to the decimal of another; finding a decimal fraction of a given quantity.

C.—*Euclid.*

(i.) *First and Second Years and Third Year Girls.*—To end of Proposition XXXIV.

(ii.) *Third Year Boys.*—Revision of Propositions XVI.–XXXII. Deductions on Propositions I.–XXXII.

D.—*Algebra.*

(i.) *First and Second Years and Third Year Girls.*—Simple Equations with more than one unknown. Problems which may be solved by their aid.

(ii.) Simple Equations generally. The knowledge gained by the previous study of Factors, etc., will be found most useful in the solution of more difficult Equations.

E.—*Mensuration.*

Parts of circles:—Rings, *i.e.*, the space between the circumferences of two concentric circles; sectors, segments.

F.—*Teaching.*

(i.) *Second Year.*—Flux's 'School Management,' Ch. V.

(ii.) *Third Year.*—Flux's 'School Management,' Ch. XII.

G.—*Geography.*

Commerce of British Isles, Australia, and British North America. Revision of general Geography, England and Wales.

H.—*History.*

Reigns of Richard I. and John. As the former brings before us the subject of the Crusades, a brief outline of these expeditions should be mastered. The events of the reign of John are best remembered under three heads:—(*a*) His quarrel with the king of France about Arthur, involving the loss of Normandy. (*b*) His quarrel with the Pope about the appointment of Stephen Langton. (*c*) His quarrel with the Barons, resulting in Magna Charta.

TEST QUESTIONS ON LAST MONTH'S WORK.

First Year.—1. What is an Abstract Noun? What is a Collective Noun? How are Collective Nouns considered when applying the syntactical rule which requires the Verb to agree with its Nominative in Number?

2. What is the difference between 'sex' and 'gender'? Give the feminine forms corresponding with the following:—Hero, earl, duke, emperor, bachelor, gander.

3. What is a 'diminutive'? Give the diminutive forms of—hill, brook, animal, man, lamb.

4. What is the difference between a 'compound' and a 'complex' fraction? Show that $\frac{3}{8}$ of $\frac{7}{11} = \frac{7}{11}$ of $\frac{3}{8}$, by means of a diagram.

5. Find the G.C.M. of 1911 and 2205, and prove that it is the *greatest* common measure.

Second Year.—1. Analyse the following:—

She whispered *still that* brightness *would return*;
She, in the midst of all, preserved *me* still
A *poet*, made *me seek* beneath that name,
And that *alone*, my office upon earth.

2. Parse the words in italics.

3. Paraphrase the following:—

But where to find that happiest spot below
Who can direct, when all pretend to know?
The shudd'ring tenant of the frigid zone
Boldly proclaims that happiest spot his own;
Extols the treasures of his stormy seas,
And his long nights of revelry and ease;
The naked negro, panting at the line,
Boasts of his golden sands and palmy wine,
Basks in the glare, or stems the tepid wave,
And thanks his gods for all the good they gave.

4. On what is Profit or Loss usually reckoned? A person gained 7½ per cent. by selling a horse for £26 17s. 6d.; for how much should he have sold it to gain 12 per cent.?

5. Solve the following:—

(*a*) $\frac{x+3}{7} + \frac{4x-1}{3} = x+2.$

(*b*) $(x+2)(x-5) = (x+3)(x-4) - 12.$

6. Two boys, A, B, have 60 marbles between them; if A were to give B two of his, then B would have half as many as A. How many marbles has each?

7. What is meant by the 'Look and Say Method' of teaching Reading? Distinguish between the Phonic method and the Phonetic method.

Third Year.—1. Say which of the following words are of English and which of foreign origin, and state how you are able to recognise them:—Get, if, physical, dispose, untie, myth, constant, mouse, tough, hypocrite, knife.

2. What are hybrid words? Give examples.

3. What illustrations would you use in explaining to a class that $\frac{1}{2} + \frac{1}{3} = \frac{5}{6}$?

4. Divide 4·78 by 3·5, using factors and short division.

5. By which propositions can you prove one straight line equal to another straight line, and what are the data necessary in each case?

6. What apparatus would you require to illustrate a lesson on Latitude and Longitude?

Geography.—For all Years.

1. Write an account of Tasmania.

2. Give a list of towns in Australia which have been named after statesmen, and give an account of three of them.

3. Give an account of the natural products of New South Wales.

History.—For all Years.

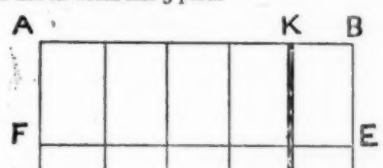
1. Give a list of the Continental possessions of Henry II., and say how they each came into his hands and where they were situated.

2. What were the chief provisions in the Constitutions of Clarendon? To which did Becket object, and why?

3. Give an account of the improvements introduced by Henry II. into the system of administering justice.

HINTS ON LAST MONTH'S QUESTIONS.

First Year.—3. Take a square or rectangle, divide its length into 5 parts and its width into 3 parts.



Now each of the horizontal strips is one-third of the whole square, and so ABGH is $\frac{1}{3}$ of the square. This is divided into 5 equal parts by the perpendicular lines, so that AKLH is $\frac{1}{5}$ of ABGH, but ABGH is $\frac{3}{5}$ of the square; therefore AKLH is $\frac{1}{5}$ of $\frac{3}{5}$ of the square; but since the square is divided into 15 equal parts, of which AKLH contains 8, AKLH is $\frac{8}{15}$ of the square. ∴ $\frac{1}{5}$ of $\frac{3}{5} = \frac{8}{15}$.

4. The division of one quantity by another is the operation by which we find how many times the divisor is contained in the dividend. Since a proper fraction is less than unity, and unity is contained in the dividend a number of times equal to itself, it is evident that the quotient obtained by dividing a number by a proper fraction must be greater than the number itself.

Second Year.—3.—

Total of the 8 numbers = 8 × 9·45 = 75·6.
Total of the first 7 numbers = 7 × 8·75 = 61·25.
∴ the eighth number = 75·6 − 61·25 = 14·35. Ans.

4. By taking 8 gallons of wine at 38s. a gallon (*i.e.*, 5s. above the average), the cost would be 8 × 5s. = 40s. above the average. Of each gallon at 25s. the price is 8s. below the average. Therefore $\frac{40}{8}$ gallons must be taken to clear off the excess caused by the dearer wine. $\frac{40}{8} = 5$. Ans. 5 gallons.

5. Twenty books were worth 4s. 9d. each (*i.e.* 1s. 3d. above the average price). The total cost of these 20 was therefore 25s. above what they would have cost if each had been worth the average price. On each of the others there is a deficiency of 3d.; and since this cleared off the excess caused by the books at 4s. 9d., there must have been 100 of them $\left(\frac{25s.}{3d.} = 100\right)$.

Total number of books therefore = 100 + 20 = 120 Ans.

Third Year.—6. A vulgar fraction will reduce to a non-recurring decimal, if, when reduced to its lowest terms, the denominator contains no other prime factors than twos and fives. In all other cases it will recur.

7. $\cdot 07\dot{2}3\dot{5} = \cdot 07235235235 \ldots\ldots$ to infinity.

Multiply these equals (a) by 100,000, and (b) by 100.

(a) $100{,}000 \times \cdot 07\dot{2}3\dot{5} = 7235{\cdot}235235 \ldots\ldots$ to infinity.

(b) $100 \times \cdot 07\dot{2}3\dot{5} = 7{\cdot}235235 \ldots\ldots$ to infinity.

Subtract (a) from (b), then

$$(100{,}000 - 100) \times \cdot 07\dot{2}3\dot{5} = 7{,}228;$$

that is $99{,}900 \times \cdot 07\dot{2}3\dot{5} = 7{,}228$.

Divide these equals by 99,900, then

$$\cdot 07\dot{2}3\dot{5} = \tfrac{7228}{99900}.$$

Scholarship—Fourth Year.

Work for the Month.

Note carefully the changes in the syllabus set out above.

English Literature.—To 1660. Special attention to be paid to the decline of the drama after Shakespeare and Jonson's time. The whole of Milton's life and account of his works should be included, although he did not die till 1674.

Grammar.—Syntactical rules; more common Latin roots.

Arithmetic—Girls.—Stocks.

Arithmetic—Boys.—Vulgar Fractions. Theory, methods of teaching and graphic illustrations.

Algebra—Girls.—[Girls who have not studied Algebra are strongly advised to begin now. Not only will they be able to answer the highly-marked questions on the arithmetic paper, but they will gain a clearer insight into the theory of Arithmetic.]

Notation, Definitions, Substitution, Negative Quantities, Addition of like terms, Simple Brackets.

Boys.—Problems which require Quadratic Equations in solving them.

Euclid.—Propositions I.–XXXII. with deductions.

Geography.—British India, including tributary and protected states. Map of France.

History.—To accession of Edward IV. Genealogical table to show claims of the rival houses.

School Management.—Flux. Chapter VIII.

Domestic Economy.—Outline of the principal processes going on in a healthy body: respiration, circulation, digestion, secretions, and excretions. Rules for preserving the body in a healthy condition.

Music.—Chromatic intervals, syncopation.

Test Questions on Last Month's Work.

1. What do you know of the earliest English comedy, and of the earliest English tragedy?

2. To what extent was the rise of the English drama due to the influence of Greek and Latin dramatists, and to what extent did it spring from older native sources?

3. Write a short life of Shakespeare, and classify his writings.

4. In what ways did Ben Jonson's idea of the correct form of a drama differ from Shakespeare's?

5. How may Conjunctions be classified?

6. Give examples of the words *after*, *before*, used as (a) Adverbs, (b) Conjunctions, and (c) Prepositions, of *when* and *where*, used (a) as Adverbs, (b) as Conjunctions, and say how you would teach children to distinguish between them.

7. Prove that the difference between Banker's Discount and True Discount is equal to the interest on the True Discount.

8. If the true discount on £480 for a certain time be £40, find the true discount on £600 for twice the time, rate of interest being the same in both cases.

9. What is a Prime Number? Use the 'sieve of Eratosthenes' to find all the prime numbers below 150.

10. Give rules for shortening the working of an example in G.C.M.

11. Show that in the equation $x^2 + ax + b = 0$, a = the sum of the roots, and b = their product.

12. How many roots are there to a quadratic equation? Under what conditions will they be of equal numerical value but of opposite sign?

13. It has been said that 'had Edward III. died directly after the Treaty of Bretigny was signed he would have been considered the greatest king that ever sat on the English throne, but he lived too long for his glory.' Comment on this statement, and contrast the last seventeen years of his reign with the earlier portion.

14. Give an account of the personal character of Richard II.

15. What are the different methods of teaching Subtraction?

16. What are the advantages of a decimal system of coinage, weights, and measures?

17. Write out the Metric Table of Fluid Measure and show how the units are derived from the metre.

18. Give directions for washing (a) flannels, (b) coloured cottons.

19. What scientific principles underlie the ventilation of a living room or a class-room?

20. Give the meaning of Allegretto, Lento, D.C., Dal segno, Callando, Diminuendo, Largo, Andante.

CONVERSATIONAL LESSONS IN CHEMISTRY.

BY THOMAS CARTWRIGHT, B.A., B.SC. (LOND.),

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For particulars of the List of Chemicals and PRACTICAL TEACHER Set of Apparatus for working the experiments referred to in these lessons see numbers for January and February 1893.

LESSON XXI.—MERCURY.

WHAT is this substance, Bob? It is quicksilver, sir. Why quick, or living, for that is what quick means? Is it because it flows about, sir? Yes, and now tell me why it is called silver. Can you get silver from it? I see you hesitate, so I will help you by reminding you that the liquid is known as mercury, and that it is a metal, as you will easily guess from its appearance. Now, Tom, we will hear you. If it is a metal, sir, it is an element, and silver cannot be got from it. Of course, and it is its white colour that has earned for it the name, silver. I think it will interest you to know that the Latin name for the body is hydrargyrum, signifying *water-silver*, from the initial and middle letters of which we get Hg as the symbol of the element. Here is another element—bromine—which, like Hg, is a liquid, and if we add the rare metal *gallium* to these two, we shall have named all the elements which are liquids. Now, Lizzie, please place these two beakers upon the pans of our scales and balance them by placing shot in the lighter pan. In one pour a small amount of Hg, and then pour water into the other until the two scale-pans again balance. What do you observe? That Hg is very much heavier than water. Yes, an accurate determination would show you that Hg is about 13½ times heavier than water. It is, indeed, the heaviest liquid known. Please observe this red rock. Let Tom powder a portion of it in the mortar, and then place it in a small retort with some quick lime. Let the neck of the retort dip under water, and now apply heat to the bulb of the retort. All of you look carefully into the water now that the heating has continued for some time. You, Trixie, shall tell us what is to be found there. There is some Hg here, sir, and so the red powder is a mercury compound. Very true, and if I inform you that the lime has now been changed into calcium sulphide, you can guess what the red compound is. Well, Lilla, we will take your answer. It is mercury sulphide, sir. Exactly, and large quantities of it are found in various parts of the earth, notably at Almaden in Spain, at Idria in Austria, and in California, Peru, and Mexico, all of which places we will point out on the map in our next geography lesson. This, the commonest ore of quicksilver, is called *cinnabar*. Here you see a box of paints, one of which, *vermilion*, is simply purified cinnabar, and a very useful pigment it is. For what is quicksilver most commonly used? Proceed, Lionel. For

THE SWEET SPRINGTIME.

VOCAL DUET OR TWO PART SONG FOR INFANTS OR YOUNG CHILDREN WITH ACTIONS.

THIS PIECE MAY BE ALSO SUNG AS A SOLO.

Mm. ♩ = 160. Allegro moderato.
Words and Music by H. BERKELEY SCORE.
PART I.
PART II.
PIANOFORTE ACCOMPT.
mf. cres. mf. poco. apoco.
Key F. :n |n :n |n.r :n.f |s :-.f |n :n |f :f |n :s.n |r :— |— :s |
VERSE 1. I love I love the spring - time,(1)Sweet sea - son of de - light, (2) Each
Key F. :d |d :d |d.t, :d.r |n :-.r |d :d |r :r |d :n.d |t, :— |— :r |
crescendo forte mf. mf.
|n :s |l :s |s :-.f |n :s |d'.t :l.s |f :s.f |n :— |— :d.t, |l, :l, |r :d |
lit - tle bud is peep - ing, (3) And ev - ery thing seems bright. (4) I see the first white
|d :n |n :n |r :t, |d :n |n :n |r :r |d :— |— :s, |f, :f, |l, :l, |
crescendo forte mf. mf.
crescendo f. mf. mf.
|d :— |t, :s, |f :f |f :s.f |n :— |— :s |f :-.l, |n :r |d :— |t, :l, |
snow - drops and (5)scent-ed vio - lets blue, (6) The dai - sy and the prim - rose, And
|s, :— |f, :s, |r :r |r :n.r |d :— |— :d |l, :-.l, |l, :l, |s, :— |f, :f, |
crescendo f. mf. mf.

The Pianoforte Accompaniment is so arranged to this Duet that the Treble upper notes may be taken as a Solo if necessary.

(8) Each busy bee is working
Throughout the whole day long;
(9) The birds are building quickly,
To sing their summer song.
(10) The lambs are in the meadows,
Each little one at play;
(11) The rivulet seems dancing,
And rippling on its way.
Chorus—Tra la la, &c.

(12) The cuckoo's in the woods now,
(13) The schoolboy hears its cries;
(14) And merry flights of swallows
From far-off sunny skies.
(15) The rooks are cawing loudly
Among the tree-tops high,
(16) And sometimes in the sunshine
(17) I see a butterfly.
Chorus—Tra la la, &c.

Altho' I love the Springtime,
(18) I must not always play,
(19) But try to learn my lessons
And work hard every day.
Then when sweet summer cometh,
Life's season of delight,
(20) To Him I'll yield my ripe fruits
Who made the Springtime bright.
Chorus—Tra la la, &c.

ACTIONS.

(1) Clap hands.
(2) Point to eyes.
(3) Wave hands round room.
(4) Point to floor.
(5) Imitate smelling a flower.
(6) Same as 4.
(7) Clap hands, beat time with feet, or march round the room.
(8) Imitate working with hands, or twirl hands round each other.
(9) Point to ceiling or windows.
(10) Point to door or windows.
(11) Move hands up and down or jump up.
(12) Same as 9.
(13) Hold hands up as if listening, or point to each other.
(14) Imitate flying.
(15) Same as 9.
(16) Point to windows.
(17) Point to eyes.
(18) Shake heads.
(19) Imitate working sums or looking at books.
(20) Point to sky.

thermometers and barometers, sir. Yes, and you, Ada? For mirrors, sir. Quite true, and you, Maud? In our geography lesson, sir, you told us that quicksilver was used in separating gold from the dross with which it is found. Very good, and that will lead us to a very interesting experiment which you, of course, must perform. Take a portion of this tinfoil and make a thimble-shaped vessel which shall just fit into the top of the test tube. Now carefully pour in some of the Hg. Ah, you see the tinfoil will not hold the Hg. Why? I see you are nonplussed; but what is one of the chief properties of water and other liquids? Think of tea and the sugar which you put into it, and now tell me why the tinfoil will not hold the Hg, Winnie? The Hg, sir, dissolves some of the tin, and so eats its way through. You are right, and Hg has the power of dissolving most metals in this way, the product being an *amalgam*, which is the special name given to an alloy of Hg with other metals. See how easily this penny is silvered. The same applies to gold, and so if a portion of Hg be mixed with some gold, containing sand, the gold will at once amalgamate with the Hg and separate itself from the dross. To separate the Hg from the gold is a very easy process, since it is only necessary to heat Hg to 357° C. to volatilise it, and the vapour thus produced is at once condensed into liquid Hg, and so available for use again. If we heat the Hg to 300° only, it will slowly become encrusted with a red film similar to this substance which you see is marked 'Mercuric Oxide.' Place some of it in this hard-glass tube, and what will come off, Arthur? Oxygen, sir, as we found in our lesson on that gas. Yes, you will recollect that this was the method by means of which Priestley, the discoverer of O, succeeded in separating that body from the atmosphere, and so this red precipitate, as it is called, will always have a historic value. Hg is particularly suitable for thermometers, as it does not freeze until —40° C. is attained, and only boils at 357° C., thus having a range of temperature of 400° C. It has also many other properties, which make it the most convenient of all liquids for measuring heat by its expansion. Like gold and platinum Hg does not rust in air, as we have already seen. It is, therefore, one of the *noble metals*. Place a small globule of Hg in a test tube, Mabel, and pour thereupon some HCl. What do you note? It does not dissolve. Now, test another portion with HNO_3. Ah, it soon dissolves; forming what, Nellie? Mercury nitrate, sir. Yes, and if you heat the nitrate you can easily obtain the oxide and the metal itself, an experiment which we will ask Isabel to perform. We have not exhausted the list of the useful offices performed by the water-silver. Here are two bodies to which the doctor attaches much value as medicines, one you will notice is called *corrosive sublimate*, the other *calomel*. To show that these bodies contain Hg we will powder some of the sublimate and place it in a tube with some carbonate of soda and apply heat to the mixture. Observe the cool part of the tube and you will see upon it some globules of mercury. It is found that the sublimate contains twice as much Hg as calomel, and as both compounds contain Cl, the former is called mercuric, the latter mercurous chloride, the terminations *ic* and *ous* indicating *more* and *less* respectively.

Let us now sum up what we have learnt concerning this very interesting metal:—

(1) That it occurs in nature mainly as the red sulphide—cinnabar (HgS).

(2) That it is a heavy liquid with a specific gravity of 13·5. That it boils at 357° C. and freezes at —40° C. That it is insoluble in HCl, but dissolves in HNO_3. That it sublimes when heated, and dissolves other metals, forming amalgams with them.

(3) That it is used for thermometers, for silvering mirrors, and for separating gold from dross.

(4) The red precipitate (HgO), *vermilion* (HgS), used by the artist, and calomel (HgCl) and corrosive sublimate ($HgCl_2$), used by the doctor, are its most interesting compounds.

ELEMENTARY LESSONS IN AGRICULTURAL ZOOLOGY.

BY PROFESSOR J. R. GREEN, SC.D.,
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CHAPTER III.—Rodentia (Gnawing Mammals) and Ruminantia (Cud-Chewing Mammals).

The natural order *Rodentia* comprises Gnawing Mammals, whose name is derived from their possessing two long incisors, the crowns of which are continually being worn down by the process of gnawing, while a corresponding growth takes place at the root end. The crowns maintain a chisel-edge, however, owing to the presence of a thick layer of enamel in front, which causes the teeth to wear down less in front than at the back. Occasionally abnormal teeth are present, through the usual wearing-down process not having taken place. This may happen in one of two ways: either the lower jaw may be placed obliquely under the upper jaw, or a tooth may be absent in one jaw. The incisors then become tusk-like structures, continuing to grow, and ultimately curving upwards or downwards. Most Rodents have a springing gait, which results from the hind-feet being longer than the fore-feet. Their eyes are large.

The family of Rodents known as *Leporidae* comprises hares and rabbits, animals that are among the farmer's most destructive foes. They agree in possessing the following characteristics: a rather long skull, two small incisors behind the two large upper ones, long spoon-shaped ears, and a cleft upper lip.

The Hare, *Lepus timidus*, has ears longer than the head, while those of the Rabbit, *Lepus cuniculus*, are shorter than the head. The hare has yellowish-brown eyes, the rabbit has dark-brown eyes. There is also a difference in their fur, that of the hare being rusty-yellow to grey on the upper side, and white underneath, while that of the rabbit is yellowish-brown to greyish-yellow on the upper side, and redder in front; underneath it is of a bluish-grey. The rabbit is also more compressed in shape than the hare.

The bed of the hare is called its *form*. From two to four leverets are littered four or five times a year, covered with hair and with their eyes open. The hare is a foe to the farmer *directly*, because of its eating cabbages, rape, turnips, clover, vetches, the young corn, carrots, and grass; *indirectly*, because of the sport it occasions.

The damage done by the rabbit in our colonies has led to the adoption of active measures for its extermination, and in England to the passing of the Ground Game Act of 1880, which gave occupiers of land the right to protect their crops from injury by ground game by killing them under certain conditions.

It breeds very rapidly, the doe bringing forth from four to eight young, five to six times yearly. After six months the young are themselves capable of continuing the species. Unlike the young of the hare, they are blind and hairless at birth. Its burrowing is the occasion of great damage, not only to the crops, but in sand hills and alluvial sandy soil it

leads to the blowing away of the soil, which is held together by sand-plants.

The Rodents comprising the family called *Muridae* are light and nimble, with large ears, bright eyes, and long, scaly tails. The hind-legs are longer than the fore-legs, which makes their gait a kind of hopping. Their fur is sombre in colour and soft.

The Brown Rat (*Mus decumanus*) is a heavily-built animal about eight or nine inches long; its fir is a uniform grayish-brown above and white below, the ears, feet, and tail being flesh-coloured. It is believed to have originated in China, and to have migrated from Asia to Europe during the early part of the eighteenth century. The Black Rat (*Mus rattus*) is smaller than the Brown Rat, not generally exceeding seven inches in length. Its tail is eight or nine inches long. Both these species eat almost everything, and multiply very rapidly. Their food consists of insects, mice, eggs and chickens, young geese and ducks, grain, peas, beans, carrots, potatoes, and turnips. They can be driven away by clacking mills, and kept down by traps.

The Wood Mouse, *Mus sylvaticus*, the Harvest Mouse, *Mus minutus*, and the Corn Mouse, *Mus agrarius*, are all injurious to agriculture. The Wood Mouse often takes to barns and out-houses for shelter during the winter, and, though its home is woods, is often found in plantations and gardens. In appearance it is of a light reddish-grey colour, with a pure white belly, and it has relatively very long legs. The Harvest Mouse is the smallest of the European mice, seldom exceeding two inches and-a-half or three inches in length. The tiny creature is rather pretty, its back being of a yellowish-red colour, and its belly white. During the summer it lives in cornfields, and is found in harvest time by the field paths. It builds a beautiful globular nest, about the size of a cricket ball, out of the haulms and leaves of grass and corn. In this the young are nurtured. It climbs among the grass and corn haulms, holding fast not only by its feet, but by its tail. For food it devours seeds, especially grain, being very fond of oats. The Corn Mouse is of a brownish-red colour, with longitudinal black stripes. It lives, for most of the year, in cornfields and fruit fields, where it digs holes in the soil, but winters in barns and farm houses. Its food consists of grain, beans, peas, potatoes, turnips, and carrots.

The Voles, comprising the family *Arvicolidae*, closely resemble the preceding family, from which they may be distinguished by their more clumsy and heavy make, and their less graceful movements, the small size of their eyes, the bluntness of the muzzle, the small ears quite hidden in the fur, and the short tail on which no rings of scales can be distinguished.

The Water Vole, often called the Water Rat, *Arvicola amphibius*, is about the same size as the Brown Rat. Its fur is long, soft, and thick, and of a grizzled-brown colour. The tail is about half the length of the head and body, and the hind feet are very long and powerful, and have five rounded pads on their lower surfaces. Not only is it found on the banks of rivers, brooks, ditches, and canals, but also in damp low-lying meadows and fields, where it does as much harm by its digging as the mole. The much-branched passages that it digs in the soil frequently undermine embankments. The Water Vole inflicts much damage on the farmer, for, though it occasionally eats insects and worms, its usual food consists of grain, potatoes, turnips, and carrots, which it stores up in its hiding-place. In its burrowing it destroys the roots of grass and corn, and it will eagerly devour chickens and the eggs of ducks and geese. These voles are kept down by means of traps, shooting, and poisoning with celery stumps, hollowed out and filled either with phosphorus or phosphorus paste.

The Field Vole, *Arvicola agrestis*, is a very small animal with dark-brownish fur. Its body is short and stumpy, and its hind feet have six pads on their lower surfaces. It frequents fields, woods, and gardens in enormous numbers, and does great damage there. Large numbers are found together in low-lying damp pastures, where they make deep burrows in the soil. They increase very rapidly, three or four litters, each numbering four to ten young, being produced in a year. Its favourite food consists of roots and the young shoots of grass, but it is fond of all sorts of vegetable produce. Preventive measures help to keep down this pest. They may be caught in traps, etc., in the spring, when they are only present in small numbers, and the protection of their natural enemies, the weasel, stoat, polecat, fox, hedgehog, owls, buzzards, kestrels, and the smaller seagulls, is advisable. In infested districts destructive measures have to be resorted to. When a field has been completely devastated by this plague, or the crop is over, the soil may be worked with a spiked roller, or the lower lying fields may be partially inundated. Where it is necessary to spare the crop, cylindrical holes six inches across and two feet deep may be dug at the margins of the fields and in the furrows, as well as on any foot paths that may be found. The voles fall into these holes, and, as they cannot get out, they die of starvation. They may also be poisoned with phosphorus paste.

The natural order *Ruminantia* comprises those cud-chewing Mammals whose stomach consists of four sub-divisions—the *rumen*, or paunch, where the greater part of the food and water taken collects, the *reticulum*, or honey-comb stomach, the *psalterium*, or manyplies, and the *abomasum*, or rennet stomach. After the food has remained for some time in the paunch it passes up again through the gullet, and as the "cud" undergoes a second chewing. The soft mass thus produced is swallowed again, and passes into the psalterium and abomasum. The feet end in two hoof-covered toes, besides which two 'after toes' are present.

The family of Ruminants called *Cervidae* is represented in Britain by the Red deer, *Cervus elaphus*, the Roebuck, *Cervus capreolus*, and the Fallow Deer, *Cervus dama*. Their characteristic antlers are outgrowths of true bone, covered during their growth with vascular sensitive integument coated with short hair. As soon as the growth of the antler is complete, the supply of blood to it ceases and the skin dies and peels off, leaving the bone bare and insensible, and after a time, by a process of absorption near the base, it becomes detached from the skull and is 'shed.' A more or less elongated portion, or 'pedicle,' always remains on the skull, from the summit of which a new antler is developed. Under favourable conditions the animal acquires a new side branch as long as he continues to get bigger and stronger. The one year old male, or 'brocket,' has,

therefore, a simple unbranched antler; the two year old, or 'spayad,' a side branch as well; the three year old, or 'sorel,' three points; the four year old, or 'staggard,' four points; the five year old, or 'stag,' five points.

Three species of deer are now found in England, two of which, the Red Deer, *Cervus elaphus*, and the Roebuck, *Cervus capreolus*, are indigenous to Britain, while the third, the Fallow Deer, *Cervus dama*, is a native of Asia Minor and the South of Europe.

The Red Deer is the largest species of the three, being six to seven feet long and four feet high. Its rough cylindrical antlers have two front branches, a middle branch, and a crown; and the tail, which is short, has a light yellowish-brown spot on it. The brownish body assumes a red tint in summer, from which the animal derives its name. The hind bears usually one, occasionally two 'calves' in May or the early part of June, which are spotted with white till their first change of coat in October. Towards the end of February the stag sheds his antlers, and whilst the new ones are growing he keeps to the low woods, not repairing to the high-lying forests before July, by which time they are full grown. Red deer are very injurious to the agriculturist and forester. Not only do they feed on the farmer's field crops—cabbages, peas, beans, turnips, carrots, potatoes, clover, lupines, and young corn—but they also do a great deal of damage by trampling them down. In the autumn and winter their food consists of acorns, beech nuts, the buds and young shoots of various trees, and they peel the bark from young trees.

The Fallow Deer is smaller than the Red Deer, being about four feet long and three feet in height. The antlers have smooth, flat shovel-like ends. In colour the winter coat is pale-brown, the summer one reddish and brightly spotted. The belly is whitish, and there is a white patch on the tail. The Fallow Deer lives in large herds, and consequently occasions much damage by its trampling when, towards evening, it leaves the forest to seek its food in the cornfields.

The Roebuck is the smallest species of deer occurring in England, being only about three and a half feet long and about two feet high. The antlers, which are only slightly branched, are rough all over, and the legs are long and slender. The summer coat of greyish-brown has a reddish tinge, and the longer winter coat is of a brownish-grey tint. There is a whitish patch on the rump, and the brownish coat of the young 'fawns' is at first spotted with white. Two are borne by the doe in May or June. The favourite haunts of the Roebuck are the lower forests, especially where glades and meadows or cornfields alternate with woodland. Like the Red and Fallow Deer it comes out of its cover in the evening to eat in the fields and meadows, withdrawing again towards morning. It is fond both of young corn and corn in the ear, also of ears of millet, and of beans, peas, clover, and lupines.

A word or two must be said here of the natural order Pachydermata, or thick-skinned Mammals, since domestic swine belong here. They comprise non-ruminating hoofed animals with a thick, naked, or scantily haired, frequently bristly, skin, and with three to five toes. To enter into a description of so well-known a farm animal as the pig would be outside the scope of these papers. The same consideration applies to the natural order *Solidungulata*, Single-hoofed Mammals, to which the horse and ass belong.

To recapitulate, we have seen that:—

1. The Natural Order *Rodentia* comprises gnawing animals possessing two long incisors, the crowns of which are constantly being worn down, while a corresponding growth takes place at the root end.
2. The family *Leporidae* includes hares and rabbits, which agree in possessing a rather long skull, two small incisors behind the two large upper ones, long spoon-shaped ears, and a cleft upper lip. Both are destructive to agriculture, the hare feeding on cabbages, rape, turnips, clover, vetches, and young corn, and the voracity of the rabbit and the injury done by its burrowing have occasioned special legislation.
3. The members of the family *Muridae* are light and nimble Rodents with large ears, bright eyes, long scaly tails, and a hopping gait. Brown and Black Rats eat almost everything, and increase with great rapidity. The Wood Mouse, Harvest Mouse, and Corn Mouse are especially fond of grain.
4. The family *Arvicolidae* includes Rodents closely resembling rats and mice, but differing from them in their more clumsy form, small eyes, blunt muzzle, minute ears, hidden in the fur, and shorter tail. The Water Rat or Vole feeds on grain, potatoes, turnips and carrots, does much injury by burrowing, and devours chickens and the eggs of ducks and geese. The Field Vole feeds chiefly on roots and the young shoots of grass, but is fond of all sorts of vegetable produce.
5. The natural order *Ruminantia* comprises Cud-chewing Mammals, whose stomach consists of a rumen, or paunch, a reticulum, or honeycomb stomach, a psalterium, and an abomasum, or rennet stomach.
6. The family *Cervidae* is easily distinguished by its antlers. It is represented in Britain by the Red Deer, Roebuck, and Fallow Deer, all of which do much damage to agriculture, indirectly by their trampling, and directly by attacking field crops.

NOTES AND NOTIONS.

BY RICHARD WADDINGTON.

At last the long-sought Superannuation Scheme of the Departmental Committee is to hand. It is marked by neither undue generosity nor utter inadequacy; in fact, it is a practical scheme that may well form the basis of legislation. The chief provisions are—

1. Compulsory retirement at 65.
2. Retirement after 10 years' service on proof of incapacity.
3. The Scheme is to be compulsory for all future teachers and optional for present teachers.
4. On leaving the profession the contributions are left, but at 65, even if not teaching, the annuity bought by the contributions will be paid.

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There are many teachers that will be disappointed. The age is too high without a doubt, but the opposi-

tion to the age is considerably reduced by the breakdown provision after ten years' service. Between 55 and 65 a teacher practically is guaranteed the same amount of superannuation, if compelled by ill-health to retire before 65. Again, the very well-paid teachers could rightly object to compulsory retirement at 55 or 60 with so small a provision; therefore, I take it that, with a generous administration of the breakdown clauses, the age of 65 looks less formidable than at first sight.

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PRACTICALLY, the future teachers who enter the profession after the Bill becomes law will receive superannuation at 65 years of age amounting to £66 for men and £44 for women. The existing teachers who are now 65 years of age will receive £46 as superannuation. Generally, for existing teachers under 40 years of age, the superannuation will vary from £66 to £48 per annum for men and from £44 to £37 for women. This is not liberal, nor is it generous, but it is a beginning. Every exertion possible ought to be put forth to get the Bill through the two houses within the present session. In a few years, when public opinion is more appreciative of the work of the teacher, we may hope to improve the position, as has been done twice over with the Police Superannuation. It is not the amount of superannuation I should like—it is not what I feel I deserve—but it is all that is possible just now. To argue the matter of improvement now means the dropping of the question during the existence of this Parliament. That, I hope, teachers won't be a party to. It is a good plan when you can't get all you want to take what you can get and trust to the future; that is the position on this question. Don't let us throw the opportunity away.

* * * * *

A GOOD many excuses for absence from school have been penned, but the following reply to a request for the reasonable cause of absence is the latest: The parent said, 'Ay, maister, my lad's two yards high and I'm feared o' something happenin' between him and th' teacher.'

* * * * *

WHEN are we going to abolish the Drawing examination in Evening Continuation Schools? The fixed examination was abolished because the students disappeared before the examination, but it would seem that the Drawing is for ever to be examined under the old plan. And what about the results? They are just as erratic and incomprehensible as are the day school results. Here is a school with 130 men and boys taking drawing under a special course suited to the locality. Five teachers were employed for 26 hours during the session, and the grant came to £9 15s. 0d. If reading had been taken in lieu of drawing, the grant would have been £21 15s. 0d., and the cost insignificant. And this is how the Science and Art Department seeks to cultivate a general ability to draw, at the expense, too oft, of the teacher's time, money, and reputation; but we are used to this from South Kensington.

* * * * *

THE New Code for 1895-6 lies before me. It is full of disappointment; in fact, if it were not for the generous and rational spirit of the Instructions to Inspectors, the Code would hardly be worth a word of praise. Let me enunciate a few of the disappointing portions of the Code. It practically enforces two class subjects on all schools, rural and urban. When this is realised we shall hear loud complaints from the country teachers, and rightly so. Hitherto one class subject has sufficed, and the notice that this must not be needlework has not come into force before, by the making of Object Lessons and Suitable Occupations obligatory, the minimum number of class subjects is increased to two. For the school year commencing after August 31st next Object Lessons and Suitable Occupations must form part of the instruction of the first three standards; these may be taken as Class Subjects. If they are taken as Class Subjects in the first three standards two class subjects will be required throughout the school, hence two class subjects will be the universal course. The alternative is to take Object Lessons or Suitable Occupations as a Class Subject and an Obligatory Subject. Suppose Object Lessons form the Class Subject, then Suitable Occupations must be taken. Then the result is that only one Class Subject will be taken in the eyes of the Department, but that practically the work of two Class Subjects must be accomplished.

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Now take the relief granted in the three R.'s. The Arithmetic of the fourth and fifth standards is lightened, but the work of the sixth standard is increased very considerably. The work omitted from the fourth and fifth standards must be taken up in the sixth standard, and in addition, 'Mensuration of rectangles and rectangular solids' for boys. What this last addition means is not quite certain; if it only means easy problems, such as have often appeared in the fifth and sixth standard tests, then it is not a very great burden; but, if it means, as it may, questions involving a knowledge of square and cube root, then the requirement is altogether excessive, and instead of the work being reduced for the sixth standard it is very materially increased. Until this portion of the work is defined, arithmetic must perforce continue to be unduly prominent in the school time-table despite the benevolent suggestion of the 'Instructions to Inspectors' to the contrary.

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THE case of the Class Subjects is still worse. The inclusion of Object Lessons and Suitable Occupations in the list of Obligatory Subjects will decide the two Class Subjects to be taken in the first three standards. These will, of course, be Object Lessons and Suitable Occupations in the majority of schools. Beyond the third standard two other Class Subjects will be chosen as a rule.

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SUPPOSE English and Geography are the two Class Subjects taken in the fourth and higher standards. No allowance has been made in these two subjects for the absence of their teaching in the first three standards. 'Parsing easy sentences' is still to be exacted from the fourth standard, although the three years' previous preparation will be dispensed with; and in Geography the fourth standard will be required to take up the work of the third and fourth standards in one year, as the British Isles still form part of the work, regardless of the fact that the Geography of England and Wales will not be

covered in the third standard. All the benevolent platitudes of the 'Instructions to Inspectors' count for little if the Code is to do so little to remove the over-pressure that admittedly exists. It is within the covers of the Code that the teacher will find the year's work, and it just within those pages that the absence of relief is most apparent.

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NOTHING more sympathetic and truly educational has been issued from Whitehall than the 'Instructions to Inspectors.' Would that the Department could ensure their administration in the spirit in which they are conceived; but that were possibly too much to expect just yet, although there is evidently a good time coming. Every teacher will welcome the additions to Paragraph 4, which define the tests to be applied in English. There is just one curious contradiction. The two following extracts are hardly in harmony:—

'Unless teachers, who are particularly interested in the subject, desire to give lessons of a more advanced character, it would be wise to restrict the nature of the sentences employed, so that in the lowest four standards the subject or object should be only nouns or pronouns with simple modifications, *and that auxiliary verbs* and all moods, except the indicative, should be excluded from the predicate.'

'In the fourth standard compound verbs in the indicative mood, both of the active and passive voices, and other modifications of the predicate, might be introduced:—

1. The king *had taken* away the crown from his brother.
2. The highest peak *does not mark* the line of perpetual snow.
3. The first line *was broken* by the enemy's fire.'

* * * * *

GRATEFUL as I am for the improvements in the Code, and especially the Instructions, a more than cursory perusal must convince us all that much requires to be done ere we reach a rational system of education. The unfair distinction between teachers who have been through a training college and those who have not still exists in Art 73. The deputation to the Vice-president, and the information subsequently supplied by the executive of the N.U.T., proved the case down to the ground. The time for stating the case is past. If the Union will show a determined front and press the matter in the House the distinction will soon disappear. I hope Conference will unmistakably pronounce on this neglect of the Vice-president to remove a glaring anomaly.

* * * * *

THE Annual Examination is to go at last. 'Threatened men live long' is an old proverb that teachers have felt the truth of. The unreal, unnatural, uneducational annual exhibition is going, but going slowly. My Lords say, 'It is the intention of the Department that this provision should be applied to schools which have reached upon the whole *a good educational standard*, and that only those schools should be annually examined to which you may judge it to be necessary to apply a more exact test of efficiency.'

* * * * *

WHAT will be 'a good educational standard' in one district will be below a good educational standard in another. I regret the Department, after the experience of the Infant School farce of the past year, has not taken the bull by the horns and declared that every school that has not been warned as inefficient is to be exempted from the Annual Parade.

THE circumstances under which the visits without notice are to take place show the spirit of consideration present in the Instructions but absent from the Code. The Inspector must enter the report in the log-book at the time of visit; therein lies the security of teachers. The time will soon arrive when the Union will have to afford its members another tangible benefit in the shape of Inspectorial Defence. It is not difficult to understand that the care with which the report in the log-book is written will depend very largely on the possibility of its immediately receiving attention at the hands of a Union Inspector. Nay, I can imagine that the existence of such an official would tend to many of these entries being made in lead pencil in the first instance in order to see whether there was possibility of appeal. So much of the success of intermittent inspection depends upon the ready and impartial nature of the appeal from the Inspector's decision that some such step will have to be taken I feel sure. It would be a wise thing for the Union to take time by the forelock in this matter I feel sure.

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Is there any reason why, in the case of those schools that are not to be submitted to the fixed examination, the grant should not be paid in quarterly instalments as is the fee grant? Too often a large portion of the teacher's salary is held over until the grant arrives two or three months after the year ends. With the school exempted from the fixed examination there could be no variations in the grant for that year, as under the Instructions the grant can only be reduced *or raised* after due warning. I do not see the necessity for the 'or raised,' as it seems to me that immediately the school shows improvement the grant should be raised so long as rising and falling is to be retained, which I hope is not very long.

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THE Idle School Board can hardly be charged with extravagance. A clerk and school attendance officer in one has been advertised for. The duties will hardly allow this officer to be idle, although I fail to see how he is to live in Idle on £40 a year.

IDLE SCHOOL BOARD.—Clerk and School Attendance Officer.—The person appointed will be required to attend all meetings of the Board and committees; keep the several books of accounts; conduct the correspondence; and generally perform the duties of clerk as prescribed by the Education Department and the Local Government Board. He will also be required to enforce the regular attendance of children at school; to furnish a report to the Board from time to time of children who are attending irregularly; and, where so instructed, to conduct prosecutions against the parents and guardians of such children. Salary, £40 per annum.

Clerk, accountant, attendance officer, and prosecutor for £40 a year, or 15s. 4d. a week! Truly the name of Idle is a misnomer. Teachers know the result of this parsimony. The person appointed must have other engagements, and the School Board work is done when convenient, or not done at all.

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THE debate on the second reading of the Factory Act (Amendment) Bill shows how far public opinion has advanced on the question of child labour since Mr. Matthews eulogised the mental and physical products of the half-time system. There was no mistaking the intentions of the House of Commons. If the Bill goes through this session we shall see the

age fixed at 12 for factory employment. The operatives are discredited because we have grown accustomed to their selfish opposition to every step that leads to the emancipation of the eleven-year-old factory worker. When it is the adult operative that is under consideration, the disabilities of factory life are painted in the most sombre colours, but when it is the child worker, the factory is a palace of delight that makes one wonder at the audacity of the advocates. The game is up. At last England is awakening to the cry of the children of Clogland. The House of Commons only needed to be informed to fully realise the necessity, and during the past four years the question has been ventilated in a manner that must have surprised some of the supporters of early child labour.

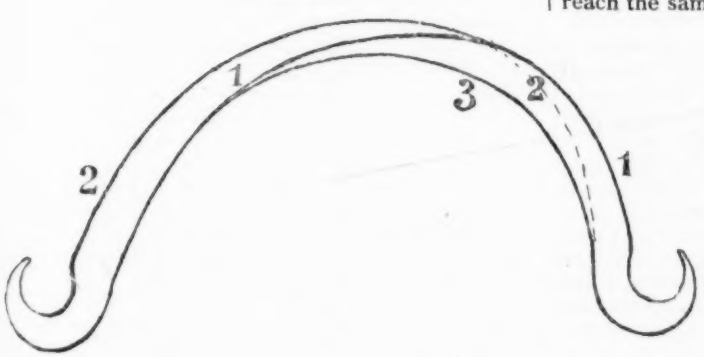
TEACHERS' DRAWING LESSONS.

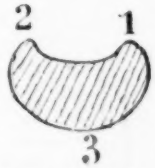
MODEL.

STANDARD VI.

BY E. BUFFERY RIDGE,
Art Master under the London School Board.

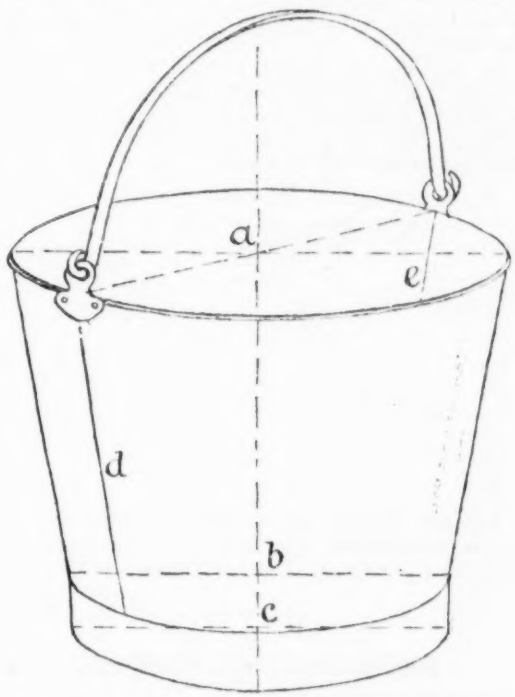
Zinc Pail.—Draw first enlarged sketches of details, as shown below. Curves 1 and 2 are similar—1 is seen throughout its length, 2 is partly hidden, 3 is seen in some views, but not in all. This model has the peculiarity of looking taller than it really is. Measure across the top with a ruler and stand the





Section of Handle.

ruler upright beside the rim of the pail; it will generally be found that the width exceeds the height. Draw a centre-line with cross-lines at *a*, *b*,



and *c*. Be careful about the proportion between *ab* and *bc* and the width at *a* and *b*.

The side-lines would meet in the centre-line if produced, and the lines *d* and *e* must be drawn to reach the same point. The base has vertical sides, and forms in fact a short cylinder, of which the lower curve must be slightly rounder than the upper. It may be called an 'upright rim' (see former lessons), while the rolled edge of the pail forms a 'round rim.'

Some cylindrical objects are elliptical in section, and are rather puzzling to draw. One of the best known examples is a water-can. Place it on the floor and draw the chalk round it, at the same time marking the positions of the *ends* of the can. Remove the can, and join the two end-marks *a* and *b*. Take

an angular view of *ab*, and it will be seen that it no longer coincides with *cd*, the longest apparent dimension of the figure. Notice also that the curve

is no longer a true ellipse, but looks somewhat four-sided.

In drawing the model, get *ab* (top or bottom), vanishing at the proper angle, and fit the curve to it by careful inspection (see curve-drawing in former issues). The lines *e* and *f* are wanted to fix positions of handle and spout.

Another elliptical object which is sometimes given as an examination test, and is in that connection altogether too handy, is the Inspector's tall hat.

MODERN EDUCATIONAL REFORMERS.

BY THOMAS CARTWRIGHT, B.A., B.SC. (LOND.),
Author of 'Mental Science and Logic for Teachers.' Late Director of the Birkbeck Training Classes and Lecturer therein on School Method.

No. XVIII.—GEORGE COMBE.

THE curious reader will in vain seek the name of George Combe amongst those whom the historians of education have deemed worthy of the crown of immortality. The great American 'Cyclopædia of Education,' by Kiddle and Schem, has no tale to unfold concerning our reformer: the English Cyclopædia, compiled by the present editor of the London *Daily Chronicle*, Mr. A. E. Fletcher, admirable in so many respects, does indeed devote a column to the consideration of Dr. Andrew Combe, the younger brother of the George now under consideration, whilst salving its conscience regarding George with the brief declaration that 'George Combe was an ardent advocate of popular education and social progress, and Andrew seems to have imbibed from him that profound interest in the physical and mental well-being of his countrymen which so eminently characterised him.' Yet George Combe spent the greater part of his seventy years in an unselfish and intelligent endeavour to secure universal education under State control which should be free and totally unsectarian, having as its apostles a body of well-trained teachers well versed in the laws of child-life and development, and acknowledged on all sides as worthy of the utmost respect and social consideration in virtue of the national importance of their labours. Surely such a man as this merits the reformer's laurel and an honoured niche in the Valhalla of pedagogues! This is the opinion of his biographer, and it will be the conviction of every teacher who reads the collected edition of his works, wherein may be traced the fostering care of another enthusiast in the good cause of a rationalised popular education, to wit, Mr. William Jolly, one of Her Majesty's Inspectors of Schools for Scotland, of whose earnestness in the cause of education many proofs have come under our notice, the most recent perhaps being the lately-published excerpts on educational topics from the pen of John Ruskin, which have been gathered together with as much zeal and edited with as much ability as may be witnessed in 'Education by George Combe,' of which the said Inspector of Schools is the responsible editor.

If further testimony of the deserts of our reformer and of the short-sightedness of the cyclopædists were necessary, does not Horace Mann, whose name is a household word in matters pertaining to education in the United States, and of acknowledged weight here in England—does not this honoured labourer in the cause of American popular education confess his deep indebtedness to the prophet, not without honour, save in his own country, as witnesseth thereof the words of Mrs. Mann: 'Mr. Mann looked on his acquaintance with Mr. Combe and his works as an important epoch in his life. That wise man cleared away for ever the rubbish of false doctrine which had sometimes impeded its action, and presented a philosophy of mind that commended itself to his judgment; and yet there was not a servile surrender to his views; for although he considered Mr. Combe his master in reasoning power, he did not follow him to all his conclusions'; and again, Mr. Mann himself: 'There is no man of whom I think so often; there is no man of whom I write so often; there is no man who has done me so much good as you have. I see many of the most valuable truths as I never should have seen them but for you, and all truths better than I should otherwise have done.' Sterling testimony, without doubt pointing to a man who 'fretted and fumed' upon life's little stage to some useful purpose. How comes it then that his fame is not noised abroad in these days of growing interest in the school and its worthies? By way of reply we point to two facts. In the first place he was the avowed high priest of phrenology, a science discredited and discarded by latter-day philosophers. And of phrenology we intend to make no sort of show of defence. We merely observe that, seeing that Archbishop Whately, the great logician and psychologist, could be an earnest disciple of the phrenology cult without prejudice to his logic and metaphysics, we fail to appreciate why the same amount of justice should not

be meted out to George Combe, whose educational projects and principles stood in no need of support from the science of bumps, being grounded on the surer foundations of common sense and accepted truths and laws of mental development.

In the second place, Combe was the declared opponent of sectarian education, and was even foolish enough, profoundly religious man though he was, to affix the damning name 'secular' to his school and to his system. If, after twenty years of unsectarian education, the moral and religious training in vogue in English Board Schools can be characterised as 'a nasty, ugly, misshapen beast,' by an otherwise amiable English gentleman, we may faintly imagine what amount of obloquy must have been heaped upon the head of the daring advocate of a more unsectarian and indirect kind of religious teaching than that which has called forth so much rancour in these days of boasted toleration.

Having introduced our reformer, proceed we to outline his life and give an outline, however faint, of his principles.

In 'auld Reekie' it was, in the year 1788, that George Combe was born. To the modern Athens he also owed his education, for which the High School (in which his interest was perennial) and the University were responsible.

Like so many other educational enthusiasts, Combe's inclination trended from the first in the direction of the study of mind. Hence, when Spurzeim, who had been converted to a firm belief in phrenology by Gull, visited Britain on a tour of propaganda, he found no more willing or intelligent disciple than George Combe, howbeit, as aforesaid, Mackenzie, Elliotson, Laycock, and Archbishop Whately were amongst the faithful. In all his many works on phrenology there is a decided leaning towards the application of his science to education.

In 1820 he was instrumental in founding the Edinburgh Phrenological Society, and later on contributed largely to the *Phrenological Journal*.

It is curious to observe that Combe was the rival of Sir Wm. Hamilton when that notable metaphysician became Professor of Logic at Edinburgh.

In the following year the offer of a professorship at Michigan University was refused, the rejected one continuing to devote himself to the duties of a writer to the Signet in his native city until his retirement in 1837.

In 1838 he visited America, and later on wandered far and wide over the continent of Europe, everywhere observant of the educational practices of the places wherein he found himself located. Meantime he contributed largely to magazines and the *Scotsman* upon educational topics. In particular he earnestly advocated the postponement of the all-engrossing study of classics to a later period of life, when, if necessary, the learner might bring to bear upon the study some power of abstract thought, and so avoid much nausea and waste of time. 'The intermediate years between seven and twelve might be employed in studying drawing, geography, natural history, biography, the history of foreign countries, with their productions, natural and artificial, their trade, moneys, modes of transacting business, and even a considerable portion of the elements of physical science might be made intelligible in the later years of the above period. This kind of instruction would forcibly exercise and excite the observing powers of children, and train their minds, just as gymnastic evolutions do their bodies, for higher exertions of activity and energy in after life.' Of his lectures on phrenology we need say no more than that they were frequent and popular. Interspersed with these were lectures on education, three of which, delivered in 1833, attracted much attention. In 1847 he wrote 'The Relation between Religion and Science,' and in 1848 'What should Secular Education embrace,' wherein was given expression to those views on the separation of theology from school instruction, substituting therefor the cultivation of the religious and moral problems, on the lines referred to by Herbert Spencer when advocating the spread of science instruction as likely to infuse a more truly religious feeling in the minds of those who, from examination, thoroughly understood how wonderful are the works of nature, the inference being that 'looking up from nature to nature's God' will follow. These views met with little encouragement and much opposition; but the enthusiasm of Combe was proof against discouragement, and his good temper and sensible forbearance took the sting out of the opposition, wherefore we are prepared for the next step, which was the foundation of a school in Edinburgh under the headmastership of Mr. Mattieu Williams—hence called Williams' School—the curriculum of which cannot fail to be interesting.

Besides reading, writing, and arithmetic, grammar, composition, geography, history, book-keeping, drawing, vocal music, sewing, algebra, geometry, natural history, chemistry, natural philosophy, moral science, social economy, physiology, phrenology; the materials and processes of the arts and manufactures, the characteristics and beauties of architecture, painting, sculpture, poetry, and natural scenery, as a means of awaking in the children the love of the beautiful. The school flourished until Mr. Williams was enticed to London by a better appointment, when it was closed. Other schools of the same class were founded by William Ellis the munificent, to whom are due the excellent Birkbeck schools, as well as the admirable school at Gospel Oak, N.W. About this time arose throughout the land the great cry for a system of popular education, and foremost amongst the agitators was George Combe; his pamphlet on 'Remarks on National Education, being an enquiry into the right and duty of Government to educate the people,' quickly ran through five large editions. Lectures in favour of his system of unsectarian education were delivered everywhere, and resolutions in support thereof were the invariable result of these meetings. The last speech made by the veteran in advocacy of the movement so dear to him was in December, 1851, on the occasion of a demonstration by the Public School Association in Manchester. Six years later, howbeit he was becoming more and more infirm, he wrote a brochure on 'The Teaching of Physiology in Schools,' which has been more than justified by the widespread instruction in that branch of knowledge, and 'The Relation between Science and Religion,' which was his last and, in his own esteem, his greatest work. He died in 1858, having just prior to his decease written for the *Scotsman* two articles on Irish Education and on the need for giving instruction in schools on the principles of trade, so that he continued fighting the good fight until the end.

For a list of the many writings of Combe the reader is referred to the work of Mr. Jolly, to which we are mainly indebted for the matter of the present sketch.

The favourite motto of George Combe will bear witness to his claim for consideration as a natural realist, 'RES, NON VERBA QUAESO' (Things, I seek not words), as also the following dictum, which Mr. Jolly has wisely thought worthy of a place on the title page of his work: '*We must teach the child What it is, Where it is, What it ought to do, and How it should do it, in order best to fulfil the objects of its existence.*'

To give anything like a complete idea of the many-sidedness of the reforms advocated by Combe is impossible within the short space of a magazine article.

It need only be mentioned that on the one hand he was in active sympathy with the education of the infant in the infant school, as witness his intimacy with and support of Wilderspin, whilst he was equally at home in demanding an adequate training for teachers, to make which an accomplished fact, both in England and in the United States, he did as much as any other man. Again, he was an important factor in bringing about popular education, and had a distinct hand in the creation of 'the compromise'; furthermore he bent his mind upon the establishment of a rational curriculum in all schools, giving due effect to the importance of science, and not failing to show the fallacy of that kind of education which, by cramming classical languages down the throats of children, tends to exalt the verbal memory to such an extent as to virtually exclude all other faculties, however all-important they may be.

He had the foresight to see that the only system of education possible and worthy was one which should be *free, compulsory, unsectarian, State controlled*—which should create a body of teachers capable of understanding the wants of the child's whole being, and sufficiently trained to be able to supply those wants so intelligently as to bring about all-round growth and development, for which purpose he would have a curriculum wisely conceived for working out their harmonious development.

In conclusion, we quote some of this truly remarkable man's words on the status of the teacher. Speaking of the improvement which must be made in the training of teachers and in their work, he says:—

'*Before much improvement can be expected, teachers must be raised in consideration and social rank; and this can be accomplished only by recognising their valuable attainments, and by teaching the people to appreciate and honour such qualities. In Britain (this was said in America) they are now not generally reckoned as fit companions for gentlemen; they are not presented in company. Whence does this arise? From the circumstance, it appears to me, that their occupation has not been scientific, but empirical. But this must be allowed: IF THE MAN WHO TAKES CARE OF OUR BODIES IS CONSIDERED EQUAL TO THE BEST OF US, SURELY THE MAN WHO TAKES CARE OF THE MIND, TRAINS AND INSTRUCTS IT, SHOULD NOT BE CONSIDERED AS BELOW OUR COMPANIONSHIP. SO TO CONSIDER HIM IS A RELIC OF BARBARISM.*

'*The first thing you require is a true philosophy of mind; then teachers, well trained and instructed according to this philosophy, shall be ranked as high in public estimation as any class of professional men.*'

In calling upon teachers to raise their profession by raising themselves, George Combe is voicing the great cry of the advanced teacher of to-day, and his contention that this and this alone will raise the teacher from his lowly estate is entirely true. Another recommendation of this all-round reformer is to-day receiving prominence. We refer to the practice, now extending, of the primary teacher sitting cheek by jowl with the University graduate, and so learning from the onset to assert the equality of the teaching profession with that of the 'learned professions.'

When teachers shall be University men without exception, when education shall rank as a University subject equal in importance with classics, mathematics, philosophy, or medicine, when the teacher shall be on an equality with the lawyer and the physician, then at length will education and its professors take up such a position as will satisfy the desires and the claims of the men who, like sagacious George Combe, can see things, however distorted by man's ignorant ordering, in their true proportions. That such a time is coming for the teacher with faith in himself and his calling is the opinion of the humble scribe whose delight it is to point out, however imperfectly, the excellences of such stalwarts as was the eminent educational reformer (the cyclopædists notwithstanding) George Combe.

OUR 1895 CERTIFICATE CLASS.

BY J. C. HOROBIN, M.A.,
Principal, Cavendish College, Cambridge.

1. Group (*d*). This may consist of either—
   I. One Advanced Science—200 marks; or,
   II. Two Elementary Sciences—200 marks.

2. Group (*f*). Those who take Science in this group may take either—
   I. One Advanced Science—200 marks; or,
   II. Two Elementary Sciences—200 marks;

and no marks beyond 200 can be obtained by taking a Language or Economy in this group in addition to Science.

It will be seen therefore

(1) That two Elementary Sciences are considered to be in every way equivalent to one Advanced Science.

(2) That the marks for groups (*d*), (*e*), and (*f*) are the same, viz., 200 for each.

(3) That those who take Science in group (*f*) may obtain the maximum marks without taking a Language or Economy, and therefore students who are taking this group may drop these two last-named subjects without losing marks.

TESTS FOR THE MONTH.

FIRST YEAR—WOMEN.

1. Write in text hand and smallhand:—
   'Dear is the memory of our wedded lives.'

2. Write from dictation:—
   What do you know | of the internal state of Africa? | Long as that continent | has been known to navigators, | the extreme line | and boundary of its coasts | is all | with which Europe | has yet become acquainted; | while other countries | in the same parallel of latitude, | through a happier system of intercourse, | have reaped the blessings | of a mutually beneficial commerce. | But as to the whole interior | of that continent, | you are, | by your own principles of commerce, | as yet | entirely shut out; | Africa is known to you | only in its skirts. | Yet even there | you are able | to infuse a poison | that spreads its contagious effects | from one end of it to the other, | which penetrates | to its very centre, | corrupting every part | to which it reaches. | You there subvert | the whole order of nature: you aggravate | every natural barbarity; | and furnish |

to every man living | on that continent, | motives for committing | under the name | and pretext of commerce,—acts of perpetual violence | and perfidy | against his neighbour.

3. (*a*) What is meant by the 'law of habit'? Explain how the study and operation of this law are matters of practical importance to teachers.

(*b*) Draw up full notes of lessons on—
(1) The Eye.
(2) The number twelve.

(*c*) What is meant by the 'association of ideas'? Give examples of different kinds of mental association, and show what practical bearing this question has on a teacher's work.

(*d*) What are the conditions laid down in the Code to be fulfilled in an infant school or class? Of these, which seem to you of most importance, and why?

(*e*) What are the 'class subjects'? What are the exact requirements for any two of them in Standard II. and Standard V.?

(*f*) What do you understand by the 'inductive method'? Illustrate by notes on 'a transitive verb.'

(*g*) Classify questions according to their purpose. What are the advantages and disadvantages of setting scholars to question one another at the end of a lesson?

(*h*) What are the advantages and deficiencies of the abacus as an instrument for teaching arithmetic?

4. (*a*) Why must food be masticated, and what is to be understood by 'inability to digest food'?

(*b*) Give reasons in favour of a mixed diet.

(*c*) Compare the cost, wear, and uses of cotton, linen, silk, and woollen fabrics.

(*d*) Explain the different processes of washing (i.) a calico shirt, (ii.) a flannel dressing-gown, and (iii.) a print dress, respectively.

(*e*) Give a list of the articles required (with approximate cost of each) for comfortably furnishing a working man's country cottage.

(*f*) Explain what is meant by 'inspiration' and 'respiration.' Describe the uses of these two processes and the organs concerned in performing them.

(*g*) Name the chief considerations, under the heads Foundation, Site, Light, and Drainage, which ought to be kept in view in building a house.

(*h*) Give, naming the exact proportions, the constituents of atmospheric air, and explain the separate use of each of them.

5. (*a*) Why do you think hemming a difficult stitch to teach? What are the chief faults you would guard against?

(*b*) Give a sketch of a first lesson in cutting out to children in Standard IV.

(*c*) Point out the chief similarities and differences in the working of calico and flannel patches, and why?

(*d*) Which do you consider the most difficult specimen to teach in Standard IV., and why?

(*e*) Cut out and tack together half the front and half the back of a chemise for a child of three years old.

(*f*) Fix and work a patch in calico not less than two inches square.

(*g*) Fix a band about two inches long, and on it sew a button and work a buttonhole.

(*h*) Draw diagrams of the parts of an infant's shirt (¼ inch scale).

6. (*a*) What other four contiguous tones of the scale are separated by the same steps or intervals as:—
(1) me fah soh lah.
(2) ray me fah soh.

(*b*) Which are the expectant tones of the scale, and which are the strong tones?

(*c*) Name the following intervals:—

(1) **r t.** (2) **t_1 s.** (3) **f t.** (4) **m d'.** (5) **r l.** (6) **fe t.**

(*a*) Write the time names of the following pulses:—

(1) | l., l : l ‖ (2) | l l.l ‖

(3) | :l ‖ (4) | l,l.l :l.l,l ‖

(*e*) Which of the following notes is highest in pitch, and which lowest?

t_1 (Key C), l_1 (Key B♭), m_1 (Key A♭), r_1 (Key D), **f** (Key B)

(*f*) Write the time value of each note or rest:—

| s :— | —.f :m.,f | s :—.l | r. : .m | f,s.l : s.d | r :d |

(*g*) Fill up two measures of each of the following kinds, showing rests and continuations in each example:—

(1) Two-pulse, (2) Three-pulse, (3) Six-pulse.

(*h*) State the major scale relation of the following tones:—

(1) **s**, (2) **d'**, (3) **f**, (4) **r**, (5) **t**.

7. (*a*) Write essays on the following subjects:—
(1) My strength is as the strength of ten,
Because my heart is pure.
(2) The characteristics of the poetry of Tennyson.
(3) Art and its influence on character.
(4) Post office.

(*b*) Parse the following words:—
Ulysses—(1) King, (3) matched, (8) both, (9) alone, (13) known, cities, (15) myself not least, (25) all one, (27) something more, (30) spirit, (35) well-loved, (53) unbecoming.
Tithonus—(18) wills, (40) yearning, (41) be, (43) ever thus, (47) best, saying, learnt, (72) release me.
Burleigh—(25) attended.
The Brook—(1) I, (2) he, too late, (68) maiden, (70) straight, as, as wand, (92) illiterate, (97) cause, (102) sketching, (104) let, (105) unclaimed, (123) babbling, (163) Till, listener, (169) things, (187) all, gone, Edmund, (200) forlorn, (202) tremble, (223) like her.
Ode—(13) sad, (14) as, (36) good, (124) day, (220) let, stand, (221) seen, (232) peace, (241) be.

(*c*) Analyse—Ulysses, Lines 6–17.
Tithonus, ,, 11–15.
Brook, ,, 67–73.
,, ,, 119–128.
,, ,, 209–216.
Ode, ,, 35–39.
,, ,, 151–168.
,, ,, 209–217.

(*d*) Explain the allusions or use of:—an idle king—mete and dole—lees—Hyades for some three suns—frolic—Gods—Happy Isles—Achilles—strong hours—silver star—wild team—Ayme—silver wheels—money breeds—mist of green—half English—bicker—fret—grigs—wizard pentagram—in session—Golden fleece—dome of Brunelleschi—tonsured head—brionyrings—treble works—loud Sabbath.

(*e*) Write a criticism on Ulysses.

8. (*a*) Draw a full map of the six northern counties of England and of the east coast of Scotland, marking ports and river mouths.

(*b*) Describe, as to a first class, some of the causes which modify the climate in different parts of the British Islands.

(*c*) Give notes of a lesson on a river, illustrating from any one well-known river.

(*d*) St. Petersburg is almost in latitude 60° N. and longitude 30° E. Explain the difference of time between London and St. Petersburg, and calculate roughly how far one is north of the other.

(*e*) Describe clearly, as to children, the formation of dew, mist, and hoar frost.

(*f*) What do you know about the following?—a glacier, a land-slip, a river bore.

(*g*) Describe the basin of the river Po.

9. (*a*) State any facts which illustrate the condition of the working classes in England in 1815–1819.

(*b*) What was the general character of Canning's policy with regard to foreign countries? Illustrate your answer by reference to particular events.

(*c*) Who were the chief statesmen, soldiers, and men of letters in the time of George III.?

(*d*) Say what you know about each of these persons: Wolfe, Burke, Clive.

(*e*) What political events and controversies are associnted with the career of John Wilkes?

(*f*) Name some of the principal inventions and discoveries in the time of George III., and say to whom we owe them.

(*g*) How did the French revolution affect English politics? Give particulars.

(*h*) Give particulars respecting the enterprise of the Young Pretender in 1745.

10. (*a*) Prove the rule for the position of the decimal point in multiplication of decimals.

(*b*) How would you use the blackboard in explaining the following sum to a class of children who are beginning to work

such problems?—If 15 men mow 16 acres in 12 days, how many men could mow 28 acres in three days? Suppose, in a sum of this kind, the answer (the number of men) were fractional, how would you explain it?

(*c*) If 2,864 bricks are used per yard to build a tunnel which is 5,926 yards long, and 2,345 bricks per yard to build another tunnel which is 6,014 yards long, state in words how many bricks are used for each tunnel, and how many more are used for the one tunnel than for the other.

(*d*) Reduce $\frac{7}{9}$ of £39 + $\frac{1}{13}$ of £58 3s. 6d. — $\frac{1}{13}$ of 4s. 6d. to the decimal of £107 1s. 8d.

(*e*) Divide £10 between four men, five women, six boys, and seven girls, so that each woman's share is seven-ninths of each man's, each boy has half the difference between a woman's and a girl's share, each girl has the difference between a man's and a woman's share.

(*f*) In what time will £8,825 amount to £11,119 10s. at 4 per cent. per annum, simple interest?

(*g*) If a sixpenny loaf weigh 4·35 lbs. when wheat is at 5·75s. a bushel, what should be paid for 98·6 lbs. of bread if wheat were 9·2s. per bushel?

(*h*) Explain why certain vulgar fractions cannot be expressed accurately as decimals. How can you tell such fractions by simple inspection? Give examples. Divide 2·52 by ·0072.

First Year—Men.

1–3, 6–9 as Women.

10. (*a*) State briefly the advantages and disadvantages of decimalising the coinage in this country.

(*b*) A building society purchased four adjacent fields, which it divided into lots of 3½ roods a-piece. The first field measured 9 ac. 3 ro. 20 po. 9½ yds., the second 3 ac. 2 po. 15½ yds., the third 2 ac. 1 ro. 19 po. 10½ yds., and the fourth 14 ac. 39 po. 25½ yds. How many lots will the society have?

(*c*) A debt of £65 is paid in francs valued at 9¾d. each, at a time when 25 francs are worth £1. What does the creditor gain or lose?

(*d*) Find the cost of papering a room 31 ft. 4 in. long, 17 ft. 3 in. wide, and 13 ft. 6 in. high, with paper three-quarters of a yard wide at 1s. 10½d. per piece of 15 yards. (Deduct 12 square yards from the area of the walls, on account of windows, etc.)

(*e*) If a man walks 252 miles at the rate of 3½ miles per hour for eight hours a day, find how many hours a day another man must walk at the rate of 4½ miles an hour in order to walk 243 miles in the same time.

(*f*) A ship 78 miles from the shore springs a leak, which admits 2½ tons of water in 6½ minutes. 68 tons would suffice to sink her, but the pumps can throw out 15 tons in an hour. Find the average rate of sailing that she may just reach the shore as she begins to sink.

(*g*) If the manufacturer makes a profit of 20 per cent., the wholesale dealer a profit of 25 per cent., and the shopkeeper a profit of 40 per cent., what was the cost of the manufacture of an article bought at a shop for 17s. 6d.?

(*h*) If £3,256 15s. be paid for £3,908 2s. due 5 years hence, what is the rate per cent. per annum simple interest?

11. (*a*) Show that $\frac{x^3 - y^3}{x - y} > x^2 + y^2$ by xy.

Find the value of $\frac{a-b}{c} + \frac{b-c}{d} + \frac{c-d}{b}$,

where $a = 2b = 3c$.

(*b*) Find the factors of $a^{10} - 3a^5b^8 + 2b^{16}$, and of $x^4 - ax^3 + (b-1)x^2 + ax - b$.

(*c*) If $x^3 + ax^2 + bx + 10$ is divisible by $x + 2$, show that $b = 2a + 1$.

(*d*) Show that $\sqrt{5} + \sqrt{7} > \sqrt{4} + \sqrt{8}$.

(*e*) Find the square root of:

$$x^2 + \frac{9y^2}{4} + \frac{z^2}{9} + 3xy + yz + \frac{2xz}{3}.$$

(*f*) The equations $2x^3 + 21x^2 + 34x - 105 = 0$,
$2x^3 - x^2 - 76x - 105 = 0$,
have one root in common; find the other two roots.

(*g*) Solve the equations:

(1) $\frac{x-5}{4} + \frac{3x+5}{8} = \frac{2x+7}{5}$.

(2) $x + 5 - \frac{8}{x+5} = 7$.

(*h*) A scaffold 4 ft. wide is erected round a house; the house is square, and covers an area of 400 sq. ft.; how many planks 10 ft. long by 8 in. wide will be required?

12. (*a*) To bisect a given rectilineal angle. BAC is a triangle having the angle at B double of the angle at A; if BD bisects the angle B and meets CA at D, show that BD is equal to AD.

(*b*) If two straight lines cut one another the vertical or opposite angles shall be equal.

ABC is an isosceles triangle such that AB is equal to AC; BA, CD are produced to E and D, so that BE is equal to CD. Prove that the triangle BAD is equal to the triangle CAE.

(*c*) If a straight line falling on two other straight lines make the alternate angles equal to each other, the two straight lines shall be parallel to one another.

Show that a regular hexagon can be divided into three equal parallelograms. (The angle of a regular hexagon may be assumed to be four-thirds of a right angle.)

(*d*) The three interior angles of every triangle are together equal to two right angles.

Construct an isosceles triangle having the vertical angle six times each of the angles at the base.

(*e*) Parallelograms on the same base, and between the same parallels, are equal to one another. Construct a parallelogram that shall be equal to another parallelogram, and have a given perimeter.

Is this always possible?

(*f*) To describe a square on a given straight line.

On the sides AC, BC of a triangle ABC, squares ACDE, BCFH, are described; show that the straight lines AH and BD are equal.

(*g*) Define a gnomon.

Illustrate the statement that some of the propositions in Book II. are the geometrical interpretations of algebraical formulæ. Distinguish between internal and external segments of straight lines.

(*h*) If a straight line be divided into any two parts, the squares on the whole line and on one of the parts are equal to twice the rectangle contained by the whole and that part, together with the square on the other part.

Show that this proposition is numerically true if the whole line is 2 feet, and one of the parts 2 inches.

Second Year—Women.

1 and 2. As in First Year.

3. (*a*) Describe in detail the process of marking, checking, and closing the daily registers. What exception is made to the rule for final closing? Sometimes in marking registers, *a* is first entered, and 1 is subsequently marked over it. Assuming that the child thus marked as 'present' reached school before the time for closing the registers, state a method for avoiding this irregularity.

(*b*) Explain and illustrate by examples the difference between 'converse' and the 'contradictory' of a proposition; and say when and under what conditions the converse of a proposition is or is not necessarily true.

(*c*) Much time is often spent by class teachers in causing words to be spelt aloud and in repeating as an oral exercise the spelling of the same words. Do you think such an exercise useful or necessary? If not, how can good spelling be taught without it?

(*d*) What are the requirements of the Code in English and Geography in the Fifth Standard, and what books should be in use in that standard?

(*e*) Give a description of the best and most completely furnished schoolroom you have ever seen; specify in detail its dimensions, its furniture and apparatus, and its decoration. Describe particularly the form of seat and desk best calculated to secure the comfort and the healthy attitude of the scholars.

(*f*) What do you mean by 'organization'? Explain the principle on which, if you were a head-teacher, with an assistant and two pupil teachers, you would distribute the duties among the members of the staff?

(*g*) Write notes of a lesson on :
(*a*) H.C.F.
(*b*) Arctic voyages.
(*c*) Adjective sentence.

(*h*) What do you understand by a well-ventilated room? Explain, with diagrams, some effective form of window ventilation for a class-room ; and give an estimate of the amount of fresh air required by each person.

4. (*a*) Explain these terms—phosphate, cereal, albumen, leguminous, fibrin, caseine, and give examples of their use.

(*b*) How are coffee, milk, bread, beer, and butter sometimes adulterated, and by what means can such adulteration be most readily detected?

(*c*) What causes the prices of meat, fish, and vegetables to vary at different periods of the year? Give some instances showing at what times it is advantageous, and when it is disadvantageous, to purchase particular articles.

(*d*) Give a recipe for making barley-water, and say when and in what kind of illness it is most useful.

(*e*) Describe the equipment of a kitchen suited for the teaching of cookery in a country school ; and give in detail an estimate of the cost of equipping it.

(*f*) Say what you would do in the case of a child who had:
(1) Fallen into the fireplace and been burned.
(2) Been scalded.
(3) Received a deep cut with a knife.

(*g*) What are the tests for the goodness of eggs, bacon, and of fish?
What kinds of fish are most wholesome and economical? What are the special advantages of a fish diet?

(*h*) What is meant by 'stock' for cooking purposes? Give recipes for two nourishing soups.

5. (*a*) Cut out, as far as the material will allow, and complete half the front and half the back of the upper part of a boy's shirt, also one of the sleeves.

(*b*) Show each of the following stitches:—Sewing and felling, gathering, stroking, and setting-in.

(*c*) Sew on a button, and make a button-hole.

(*d*) Darn a hole, in the common method, on stocking material.

(*e*) Cut out and tack together half the front and half the back of a muslin pinafore suited to a child of two years.

(*f*) Darn a cross-cut on linen.

(*g*) On a piece of calico (6 × 6) fix a hem. On it work not less than three inches of plain stitching and three inches of feather stitching.

(*h*) Run two tucks above the hem.

6. (*a*) The tones l_1 **d** t_1 l_1 are the relative minor for **d m r d** of the major key. What tones in the relative minor correspond to—

d m r s f d m r f s m s_1 l_1 t_1 d

(*b*) Write the following intervals—
(*a*) Above *doh* an augmented fourth.
(*b*) ,, *me* a major sixth.
(*c*) ,, *doh* a minor ,,

(*c*) State the meaning of the following terms—
(1) Forte, (2) Presto, (3) Dolce, (4) M 70.

(*d*) Write two passages as note tests for Division IV.

(*e*) What measures are shown by the following?—

(1) | .s : l., t_1 | s :—.f | m., f : s | d | :— }

(2) | m :—.f : s | l :—.s : f | m : — : r |
| d : — : — }

(*f*) Give the time names for the notes, rests, etc., of (*e*).

(*g*) Write the pulse signs—
(1) For four pulse measure.
(2) ,, six ,, ,,
(3) ,, nine ,, ,,

(*h*) What do you understand by syncopation? Mark the syncopated notes in—

| .s :s :—.l | —.t :—.r' :—.d' | s.m :s.f :—.t }

7. (*a*) Write essays on the following subjects :—
(1) The character of Cordelia.
(2) The peculiarities of the style of Bacon.
(3) The right use of Metaphors.
(4) Self-Control.

(*b*) Parse the following words :—
Essay 9.—Line 2, but ; 4, especially ; 7, calleth—evil eye ; 18, what ; 19, others ; 51, redemption.
Essay 11.—Line 3, so as ; 11, retire ; 12, were reason ; 31, to can ; 33, accept.
'Lear.'—Act II., Scene 1. 57, uncaught ; 87, but now.
'Lear.'—Act II., Scene 2. 34, vanity ; 88, countenance ; 92, stands ; 93, at ; 94, having been praised ; 96, quite, he ; 97, mind ; 117, being down ; 161, approach.
Act II., Scene 5. 1, myself proclaimed ; 5, does ; 6, bethought.
Act II., Scene 4. 26, coming from us ; 32, spite ; 84, deny ; 85, fetches ; 87, fetch ; 93, well ; 99, breath ; 112, go tell ; 234, followers ; 262, superfluous ; 270, as full.
Act III., Scene 1. 9, make nothing of ; 22, that ; 25, what.
Act III., Scene 2. 19, slave.
,, ,, 4. 26, poverty ; 173, you.

(*c*) Analyse—
Essay IX.—'A man . . . another's fortune.'
'Now, to speak . . . within bounds.'
,, XI.—'All rising . . . another man.'
'Lear,' Act II., Scene 1.—'If he be taken . . . seize on.'
,, ,, Scene 2.—'Draw, you rascal . . . your ways.'
,, ,, ,, —'Such smiling rogues . . . visage.'
,, ,, ,, —'Good King . . . But misery.'
,, ,, Scene 3.—'The country . . . nothing am.'
,, ,, Scene 4.—'No, Regan . . . thee endowed.'
,, Act III., Scene 4.—'Death, traitor . . . pelican daughters.'

(*d*) Comment on :
(1) except, redoubleth, fascinate, bewitch, gadding, fellow, ostracism, tare, an evil eye, Tamerlane, cure of witchcraft, to can, good works is, scandal, license, globe of precepts.
(2) Mumbling, pinfold, sop o' the moonshine, vanity the puppet, renege, nothing almost, Bedlam beggars, bans, rive, flibbertigibbet, the web and the pin, tithing, Child Rowland, tike, Sesen, wakes, lily livered, carbonado unbolted, intrinse, halcyon, aspect, Hysterica passio, cockney, sepulchring, tender-hefted nature, sumpter, gallow, wallnewt, sallets.

(*e*) (1) Explain, giving examples, the terms reflexive pronoun, disjunctive conjunction, relative adverb, neuter verb, nominative of address, adverb of degree.
(2) Distinguish between metaphors and similes, and give some examples from 'King Lear.'
(3) Give an analysis of the Essay on Envy.
(4) Compare the characters of Cordelia and Regan, with illustrations from the play.

8 and 9. As First Year.

10. (*a*) Express in words the arithmetical truths embodied in these formulæ :—

If a be greater than b, then $\frac{a+1}{b+1}$ is less than $\frac{a}{b}$; but if a be less than b, then $\frac{a+1}{b+1}$ is greater than $\frac{a}{b}$, but less than $\frac{a-1}{b-1}$, and give a demonstration by means of numbers, such as would be helpful to a class in understanding fractions.

(*b*) Reduce £2 4s. 7½d. to the decimal of £5 ; and reduce to their equivalent vulgar fractions ·0148, and $3\cdot072 \times 1\cdot2$.

(*c*) What is the least number which when divided by 33 leaves 32 remainder, when divided by 37 leaves 36 remainder, and when divided by 43 leaves 42 remainder? Explain the process of working.

(*d*) Define interest and present worth, and find the present worth of £911 13s. 3d., due five years hence, at 3 per cent., simple interest.

SCHOOL.

Cheerfully, mf. T. CRAMPTON.

1st T. & Alto or 2nd T.
Bass
1. Ev - 'ry day at school so cheer-ful In our pla - ces we are found; When the
Key A. Cheerfully, mf.
bell rings out its wel - come, 'Tis to us a hap - py sound. Let the
Key E. b.
i - dle dun - ces ram - ble, At our les - sons we will be, Read - ing,
f. A. cres.
spell - ing, writ - ing, sing - ing, We will gay and hap - py be.

2. If we strive to do our duty,
Faithful follow every rule,
We shall win our way and prosper
When we leave our happy school.
Let, &c., &c.

3. Let us, then, like earnest scholars,
Gather knowledge while we may;
Nor among the idle dunces
Waste our time from day to day.
Let, &c., &c.

(*e*) A man invests a legacy of £3,500, half in the 2½ per cents. at 90, and half in an annuity which brings him in 7 per cent. on his outlay. Find his total income, neglecting brokerage.

(*f*) The banker's discount on a bill due in two months at 5½ per cent. is £19 5s. What is the amount of the bill?

(*g*) A makes an article and sells it to B, B sells it to C, then C sells it to D for 35s.; A makes 20 per cent., B 25, C 40 per cent. What did it cost A to make it?

(*h*) If a woman can earn ⅔ as much as a man, a boy ½ as much as a woman, and two men and one boy can earn £3 in a week, how much can ten men, six women, and two boys earn?

(*i*) The area of an oblong field, whose length is twice its breadth, is eighty acres. Find the length of its sides.

SECOND YEAR.—MEN.

1–3. As in Second Year, Women.

6–9. As in Second Year, Women.

(10.) (*a*) Prove that a quadratic equation has two roots and no more.

If the ratio of the roots of $x^2 + px + q = 0$ be equal to that of the roots of $x^2 + rx + 3 = 0$, then will $p^2 : r^2 :: q : s$.

(*b*) Find the number of combinations of n different things, taken r together.

The number of combinations of (n) things 3 together is ⅔ of the number 5 together; find n.

(*c*) Sum to 12 terms:

$$\frac{a+2b}{a-b} + \frac{3a-b}{a-b} + \frac{5a-4b}{a-b} +$$

and find the A.P. of which 11 and 120 are the 3rd and 9th terms.

(*d*) Solve the equations:—

(1) $$\sqrt{x+10} + \sqrt{x-10} = \frac{60}{\sqrt{x+10}}.$$

(2) $$x^2 - xy = 20.$$
$$x^2 + y^2 = 26.$$

(*e*) Find a number such that if it is divided into 8 equal parts, their combined product is equal to the combined product if the number is divided into 4 equal parts.

(*f*) A cubical block of wood is put into a lathe and turned into a sphere with the least possible waste; compare the weights of wood before and after turning.

(*g*) Prove that if one quantity vary as each of two others separately it varies as their product jointly.

If $\frac{x^2}{a^2}$ vary as $1 - \frac{y^2}{b^2}$ and when $x = a$ $y = 0$, find the equation between x and y.

(*h*) How many triangles can be formed by joining the corners of a pentagon in every possible way?

11. (*a*) Prove I., 47.

DCB, ABC are equilateral triangles, E is the middle point of DC; show that four times the square on AE is equal to seven times the square on AB.

(*b*) To find the centre of a given circle.

To construct a circle of given radius which shall pass through two given points.

(*c*) The opposite angles of any quadrilateral figure inscribed in a circle are together equal to two right angles.

A circle passes through four points, ABCD; under what conditions will the angle ABC be equal to the angle ADC?

(*d*) To inscribe a square in a given circle.

To inscribe in a circle a rectangle similar to a given rectangle.

(*e*) Prove II. 13.

ABC is an obtuse-angled triangle, C being the obtuse angle. D is the middle point of BC; show that the squares on AB and AC are twice the squares on AD and BD.

(*f*) To divide a straight line PQ into two parts, so that the rectangle contained by PQ, QR may be equal to the square on PR.

Prove that rectangle PQ, PR + square on PR = square on PQ; and that rectangle PQ, RQ + rectangle PR, RQ = rectangle PQ, PR.

(*g*) Through a given point in a circle draw the least possible chord.

QUERY COLUMN.

ALGEBRA.

Herne Hill.—(1) Solve:—

$$\left(x+\frac{1}{x}\right)\left\{\left(x+\frac{1}{x}\right)^2 + \left(x+\frac{1}{x}\right) - 2\right\} = 30.$$

(*Haddon.*)

$$\left(x+\frac{1}{x}\right)\left\{\left(x+\frac{1}{x}\right)^2 + \left(x+\frac{1}{x}\right) - 2\right\} = 30.$$

Put y for $x + \frac{1}{x}$.

Then $y(y^2 + y - 2) = 30$.

If we take 3 and 10 as the factors of 30, and put $y = 3$, we shall find that $y^2 + y - 2 = 10$.

$$\therefore y = 3,$$

and
$$x + \frac{1}{x} = 3,$$
$$x^2 + 1 = 3x,$$
$$x^2 - 3x + (\tfrac{3}{2})^2 = \tfrac{9}{4} - 1$$
$$= \tfrac{5}{4},$$
$$x - \frac{3}{2} = \frac{\pm\sqrt{5}}{2},$$
$$\therefore x = \frac{3 \pm \sqrt{5}}{2}.$$

(2) Solve:—

$$\left.\begin{aligned} x^2 + xy + y^2 &= 37 \\ x^2 + xz + z^2 &= 28 \\ y^2 + yz + z^2 &= 19 \end{aligned}\right\} \quad (Haddon.)$$

$$\left.\begin{aligned} (1)\quad x^2 + xy + y^2 &= 37 \\ (2)\quad x^2 + xz + z^2 &= 28 \end{aligned}\right\}$$
$$xy - xz + y^2 - z^2 = 9. \quad (4)$$

$$\left.\begin{aligned} (2)\quad x^2 + xz + z^2 &= 28 \\ (3)\quad y^2 + yz + z^2 &= 19 \end{aligned}\right\}$$
$$x^2 - y^2 + xz - yz = 9. \quad (5)$$

$$\therefore x^2 - y^2 + xz - yz = xy - xz + y^2 - z^2.$$
$$x^2 + 2xz + z^2 - xy - yz = 2y^2.$$
$$(x+z)^2 - y(x+z) = 2y^2.$$
$$(x+z)^2 - y(x+z) + \left(\frac{y}{2}\right)^2 = 2y^2 + \frac{y^2}{4}$$
$$= \frac{9y^2}{4}.$$
$$x + z - \frac{y}{2} = \frac{3y}{2}.$$
$$x + z = \frac{3y}{2} + \frac{y}{2}$$
$$= 2y.$$
$$\therefore z = 2y - x.$$

(2) $$x^2 + xz + z^2 = 28.$$
$$x^2 + x(2y - x) + (2y - x)^2 = 28.$$
$$x^2 + 2xy - x^2 + 4y^2 - 4xy + x^2 = 28.$$

$$\left.\begin{aligned} x^2 - 2xy + 4y^2 &= 28 \\ (1)\quad x^2 + xy + y^2 &= 37 \end{aligned}\right\}$$
$$-3xy + 3y^2 = -9.$$
$$xy - y^2 = 3.$$
$$xy = 3 + y^2.$$
$$\therefore x = \frac{3}{y} + y.$$

(1) $$x^2 + xy + y^2 = 37.$$
$$\left(\frac{3}{y} + y\right)^2 + y\left(\frac{3}{y} + y\right) + y^2 = 37.$$
$$\frac{9}{y^2} + 6 + y^2 + 3 + y^2 + y^2 = 37.$$

$$3y^2 - 28 = -\frac{9}{y^2}.$$
$$3y^4 - 28y^2 = -9.$$
$$y^4 - \frac{28y^2}{3} + \left(\frac{14}{3}\right)^2 = \frac{196}{9} - 3$$
$$= \frac{169}{9}.$$
$$y^2 - \frac{14}{3} = \pm\frac{13}{3}.$$
$$\therefore y^2 = \pm\frac{13}{3} + \frac{14}{3}$$
$$= 9 \text{ or } \frac{1}{3}.$$
$$\therefore y = \pm 3, \text{ or } \pm\frac{1}{\sqrt{3}}.$$
$$\therefore x = \frac{3}{y} + y$$
$$= \frac{3}{\pm 3} \pm 3$$
$$= \pm 1 \pm 3$$
$$= \pm 4.$$
$$\therefore z = 2y - x$$
$$= \pm 6 \mp 4$$
$$= \pm 2.$$
$$\therefore x = \pm 4,\ y = \pm 3, \text{ and } z = \pm 2.$$

Arithmetic.

F. Daintill.—(1) A meadow is divided into two equal parts by a paling. The grass is supposed to grow uniformly. 50 cows are put into first half, and eat it bare in 4 weeks. 4 cows are then killed, and the remainder are then turned into the second half; at the end of 6 weeks 3 more are killed, and at the end of another week, as the second half is bare, the cows are sold. At the end of another week the paling is taken down, and 85 cows are introduced into the whole field. How long will the grass last them?

First half of field lasts 50 cows for 4 weeks, that is, 200 cows for 1 week. Second half of field lasts 46 cows for 6 weeks, and 43 cows for 1 week, that is (276 + 43) cows, or 319 cows for 1 week. But in this half the grass has been growing for 4 weeks, while the cows were in the first half.

∴ 4 weeks' growth in half the field lasts (319 — 200) cows, or 119 cows, for 1 week, the grass growing in the meantime.

The grass has been growing in the first half for 7 weeks, while the cows were in the second half.

∴ Altogether the grass has been growing in the first half for 8 weeks, and this would last (119 × 2) cows, or 238 cows, for 1 week.

In the second half the grass has been growing for 1 week, and this would last (119 ÷ 4) cows, or $29\frac{3}{4}$ cows for 1 week.

Altogether there is sufficient for $(238 + 29\frac{3}{4})$ cows, or $267\frac{3}{4}$ cows for 1 week, the grass growing meanwhile.

∴ Time it would last 85 cows
$$= (267\tfrac{3}{4} \div 85) \text{ weeks}$$
$$= \tfrac{1071}{340} \text{ weeks}$$
$$= \tfrac{63}{20} \text{ weeks}$$
$$= 3\tfrac{3}{20} \text{ weeks.} \quad \text{Ans.}$$

(2) Ash saplings after 5 years' growth are worth 1s. 3d., and increase in value 1s. 3d. each year afterwards. For their growth they require each twice as many square yards as the number of years they are intended to grow before cutting. A plantation is arranged so that each year the same number may be ready for cutting. Find the greatest annual income which can be obtained per acre, allowing 20 per cent. for expenses.

At the end of 5 years gross annual income per acre
$$= \left(\frac{1}{5} \times \frac{4840}{5 \times 2} \times \frac{5}{4}\right)\text{s.}$$
$$= 121\text{s.}$$
At the end of 6 years gross annual income per acre
$$= \left(\frac{1}{6} \times \frac{4840}{6 \times 2} \times \frac{5}{2}\right)\text{s.}$$
$$= 168\tfrac{1}{18}\text{s.}$$
At the end of 7 years gross annual income per acre
$$= \left(\frac{1}{7} \times \frac{4840}{7 \times 2} \times \frac{15}{4}\right)\text{s.}$$
$$= 185\tfrac{1}{7}\text{s.}$$
At the end of 8 years gross annual income per acre
$$= \left(\frac{1}{8} \times \frac{4840}{8 \times 2} \times 5\right)\text{s.}$$
$$= 189\tfrac{1}{16}\text{s.}$$
At the end of 9 years gross annual income per acre
$$= \left(\frac{1}{9} \times \frac{4840}{9 \times 2} \times \frac{25}{4}\right)\text{s.}$$
$$= 186\tfrac{2}{81}\text{s.}$$
At the end of 10 years gross annual income per acre
$$= \left(\frac{1}{10} \times \frac{4840}{10 \times 2} \times \frac{15}{2}\right)\text{s.}$$
$$= 181\tfrac{1}{2}\text{s.}$$
At the end of 11 years gross annual income per acre
$$= \left(\frac{1}{11} \times \frac{4840}{11 \times 2} \times \frac{35}{4}\right)\text{s.}$$
$$= 175\text{s.}$$

It is thus evident that the income increases up to the 8th year, and then it decreases.

∴ Annual income per acre at the end of 8 years
$$= \tfrac{4}{5} \text{ of } 189\tfrac{1}{16}\text{s.}$$
$$= \frac{\overset{605}{\cancel{3025}} \times \overset{1}{\cancel{4}}}{\underset{1}{\cancel{5}} \times \underset{4}{\cancel{16}}}\text{s.}$$
$$= 151\tfrac{1}{4}\text{s.}$$
$$= \underline{£7\ 11\text{s. } 3\text{d.}} \quad \text{Ans.}$$

Algebra.

W. C. Knights.—If ${}^nC_r$ denote the number of combinations of n things taken r together, prove that

$${}^{n+2}C_{r+} = {}^nC_{r+1} + {}^nC_{r-1} + (2 \times {}^nC_r).$$
$${}^{n-2}C_{r+1} = \frac{(n+2)(n+1)n(n-1)\ \ldots\ (n-r+2)}{\lfloor r+1},$$
$${}^nC_r = \frac{n(n-1)\ \ldots\ (n-r+2)(n-r+1)}{\lfloor r},$$
$${}^nC_{r+1} = {}^nC_r \times \frac{n-r}{r+1},$$
$${}^nC_r = {}^nC_{r-1} \times \frac{n-r+1}{r},$$
$$\therefore {}^nC_{r-1} = {}^nC_r \times \frac{r}{n-r+1};$$
$${}^nC_{r+1} + {}^nC_{r-1} + (2 \times {}^nC_r)$$
$$= \left({}^nC_r \times \frac{n-r}{r+1}\right) + \left({}^nC_r \times \frac{r}{n-r+1}\right) + (2 \times {}^nC_r)$$
$$= {}^nC_r \left(\frac{n-r}{r+1} + \frac{r}{n-r+1} + 2\right)$$
$$= {}^nC_r \left\{\frac{n^2 - 2nr + r^2 + n - r + r^2 + r + 2nr - 2r^2 + 2n + 2}{(r+1)(n-r+1)}\right\}$$
$$= {}^nC_r \times \frac{n^2 + 3n + 2}{(r+1)(n-r+1)}$$
$$= {}^nC_r \times \frac{(n+1)(n+2)}{(r+1)(n-r+1)}$$
$$= \frac{n(n-1)\ \ldots\ (n-r+2)(n-r+1)}{\lfloor r} \times \frac{(n+1)(n+2)}{(r+1)(n-r+1)}$$
$$= \frac{(n+2)(n+1)n(n-1)\ \ldots\ (n-r+2)}{\lfloor r+1}$$
$$= {}^{n+2}C_{r+1}. \quad \text{Q.E.D.}$$

T. Billington.—Newton's Proof of Parallelogram of Forces will be found on page 11 of our Science Supplement for November last. See also Todhunter's 'Mechanics.'

'East Indian.'—We are sending you reply and papers by mail.

Our Science Section.

MATHEMATICS.

STAGES 2 AND 3, SCIENCE AND ART DEPARTMENT.

By G. A. Baxandall,

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Stage 3.

Algebra.

Example 14 (*February*).—What is the n^{th} term of

$$1 + 3x + 7x^2 + 13x^3 + 21x^4 + \ldots\ldots ?$$

We must examine some particular term, say the 4th. We have to connect 13 with the number of the term 4, and the law by which we do this must be applicable to every term. After a certain amount of trial we may observe that $13 = 4^2 - 4 + 1$, and $7 = 3^2 - 3 + 1$, and so on; hence the n^{th} term is $(n^2 - n + 1)x^{n-1}$. Or we may observe that the numbers 1, 3, 7, 13, 21, and so on, are such, that by taking differences we get $3 - 1 = 2$, $7 - 3 = 2 \times 2$, $13 - 7 = 3 \times 2$, and so on; hence we have

$$\begin{aligned} 2\text{nd} - 1\text{st} &= 1 \times 2, \\ 3\text{rd} - 2\text{nd} &= 2 \times 2, \\ 4\text{th} - 3\text{rd} &= 3 \times 2, \\ &\ldots\ldots\ldots \\ &\ldots\ldots\ldots \\ n^{th} - (n-1)^{th} &= (n-1)2, \end{aligned}$$

and by adding we get

$$n^{th} - 1^{st} = 2[1 + 2 + 3 \ldots\ldots (n-1)] = (n-1)n,$$

$$\therefore n^{th} = (n-1)n - 1 = n^2 - n + 1, \text{ as before.}$$

Binomial Theorem.—We have now arrived at a most important section of our work, and it will be useful to the student to know precisely what are the essential points which he must be thoroughly clear about. The formula for the number of combinations of n things taken r at a time will be constantly required, that is

$${}_nC_r = \frac{\lfloor n}{\lfloor r \lfloor n-r} \text{ or } \frac{n(n-1)(n-2)\ldots\ldots(n-r+1)}{\lfloor r},$$

the latter being the more useful of the two.

Read carefully Arts. 503 to 509, Tod., and particularly notice the third paragraph in Art. 506; or Arts. 161 to 169, H.K.

In doing this he will learn that when n is a *positive integer*, then

$$(x+a)^n = x^n + nax^{n-1} + \frac{n(n-1)}{1.2}a^2x^{n-2} + \ldots + na^{n-1}x + a^n,$$

$$(1+x)^n = 1 + nx + \frac{n(n-1)}{1.2}x^2 + \ldots\ldots nx^{n-1} + x^n,$$

either of which may be regarded as the statement of the binomial theorem. With one or both of these equations he must make himself as familiar as with the alphabet, then progress will be possible.

The first type of problem which requires our attention is that of writing down any term in a binomial expansion; and since this reduces to a process of copying, it should present no difficulty. Let us find the 7th term of $(2y - 4x^2)^{10}$.

The process is to put this in just the same form as $(x + a)^n$, that is, to put $2y$ for x, and $(-4x^2)$ for a, then it reads $(2y + (-4x^2))^{10}$.

Now the 7th term of $(x + a)^n$ is $\frac{n(n-1)\ldots\ldots(n-5)}{\lfloor 6}a^6x^{n-6}$, so that copying from this we get the 7th term of

$$(2y + (-4x^2))^{10} = \frac{10.9\ldots\ldots5}{\lfloor 6}(-4x^2)^6(2y)^4 = 210 \times 2^{16}x^{12}y^4.$$

It is found that, on the whole, it is more convenient to use the second form of the binomial theorem, that is

$$(1+x)^n = 1 + nx + \frac{n(n-1)}{1.2}x^2 + \ldots\ldots$$

Taking the above example in order to find the 7th term, we should first write $(2y - 4x^2)^{10}$ in the form $(1 + x)^n$, that is

$$\left[2y\left(1 - \frac{4x^2}{2y}\right)\right]^{10}, \text{ or } 2^{10}y^{10}\left(1 + \left(-\frac{4x^2}{2y}\right)\right)^{10},$$

the 7th term of which is

$$2^{10}y^{10} \times \frac{10.9\ldots\ldots5}{\lfloor 6}\left(-\frac{4x^2}{2y}\right)^6,$$

which on simplifying becomes $210 \times 2^{16}x^{12}y^4$. The advantage of using this second form does not appear evident in the particular example we have chosen, but our object was merely to show how to reduce any binomial expansion to the form $(1 + x)^n$.

Example.—Find the coefficient of x^{18} in $\left(x^2 + \frac{3a}{x}\right)^{15}$.

Now $\left(x^2 + \frac{3a}{x}\right)^{15} = \left[x^2\left(1 + \frac{3a}{x^3}\right)\right]^{15} = x^{30}\left(1 + \frac{3a}{x^3}\right)^{15}$

$= x^{30}\left[1 + 15.\frac{3a}{x^3} + \frac{15.14}{1.2}\left(\frac{3a}{x^3}\right)^2 + \ldots\ldots\right]$, in which we observe that x^{30} multiplies every term within the brackets, so that if we wish to get x^{18} finally, we must choose that term within the brackets which contains in the denominator x^{12}; this will be the 5th term, for the index of the power of x is increasing by 3 each time. The required coefficient then, is that of the 5th term, which is ${}_{15}C_4 \times (3a)^4$ or $\frac{15.14.13.12}{1.2.3.4}a^4.3^4$.

Example.—Find the term independent of x in $\left(x - \frac{1}{x}\right)^{2n}$.

Now $\left(x - \frac{1}{x}\right)^{2n} = \left[x\left(1 - \frac{1}{x^2}\right)\right]^{2n} = x^{2n}\left(1 - \frac{1}{x^2}\right)^{2n}$, in which x^{2n} multiplies every term in $\left(1 - \frac{1}{x^2}\right)^{2n}$, so that to make x cancel, that is, to get the term independent of x, we must find that term in $\left(1 - \frac{1}{x^2}\right)^{2n}$ which contains x^{2n} in the denominator. Now

$$\left(1 - \frac{1}{x^2}\right)^{2n} = \left[1 + \left(-\frac{1}{x^2}\right)\right]^{2n} = \left[1 + 2n\left(-\frac{1}{x^2}\right) + \frac{2n.(2n-1)}{1.2}\left(-\frac{1}{x^2}\right)^2 + \ldots {}_{2n}C_n\left(-\frac{1}{x^2}\right)^n + \ldots\ldots\right]$$

therefore the coefficient of the term containing x^{2n} in the denomintor is ${}_{2n}C_n$, with a — or + according as n is odd or even. This sign we settle by putting $(-1)^n$, which will be negative if n is odd, and positive if n is even. The answer is therefore $(-1)^n\frac{\lfloor 2n}{\lfloor n \lfloor n}$.

Work out Exs. XXXV., Tod., 3, 5, 10, 12, 14 or Exs. XIII.*a*, Nos. 14, 18, 19, 26, 31. Also the following:—

19. The coefficients of x in the 5th and 7th terms of $(1 + 2x)^n$ are 1120 and 1792 respectively; find n. Ans. 8.

20. If the coefficients of the $(r+1)$th and $(r+3)$th terms of $(1 + x)^n$ are equal, n being a positive integer, find r.

Ans. $r = \frac{n}{2} - 1$.

21. Find the coefficient of x in the continued product of $(1 + x)(1 + 2x)^2(1 + 3x)^3 \ldots\ldots (1 + rx)^r$.

Ans. $\frac{r}{6}(r+1)(2r+1)$.

22. Find the coefficient of x^{2n} in $(1 - 2x + x^2)(1 + x)^{2n}$ and also in $(1 - 2x + x^2)(1 + x^2)^n$, n being a positive integer.

Ans. $2n^2 - 5n + 1$; $n + 1$.

23. Find the middle term of $(x - \frac{1}{x})^{2n}$. Ans. $\frac{\lfloor 2n}{\lfloor n \lfloor n}$.

Trigonometry.

Ex. 17 (*January*).—This example was wrongly stated when given, but was corrected in February.

A, B, C are angles of a triangle, and $b = 4$, $a = 5$; find cos C if $\cos(A - B) = \frac{31}{32}$.

Making use of the fact that A, B, C are angles of a triangle, we put $A + B + C = 180$, so that any two angles together are supplementary to the third, thus $A + B = 180 - C$, and therefore $\cos(A + B) = -\cos C$, $\sin(A + B) = \sin C$, and so on.

Also $\frac{A+B+C}{2} = 90$, hence $\frac{A+B}{2} = 90 - \frac{C}{2}$, and therefore $\cos\frac{A+B}{2} = \sin\frac{C}{2}$, $\cot\frac{A+B}{2} = \tan\frac{C}{2}$, and so on. Now we must be ready to use any of these relations when the opportunity presents itself, and we must try to create the opportunity.

The fact that b and a are given should suggest $\frac{a}{b} = \frac{\sin A}{\sin B}$. Add 1 to both sides; also subtract 1 from both sides. From these two new equations we get

$$\frac{\sin A + \sin B}{\sin A - \sin B} = \frac{a+b}{a-b} = 9.$$

$$\therefore \frac{2\sin\frac{A+B}{2}\cdot\cos\frac{A-B}{2}}{2\cos\frac{A+B}{2}\cdot\sin\frac{A-B}{2}} = 9, \text{ i.e. } \tan\frac{A+B}{2}\cdot\cot\frac{A-B}{2} = 9.$$

$$\therefore \cot\frac{C}{2}\cdot\cot\frac{A-B}{2} = 9.$$

Now $\cos\frac{A-B}{2} = \sqrt{\frac{1+\cos(A-B)}{2}} = \frac{3\sqrt{7}}{8}$, and therefore $\cot\frac{A-B}{2} = 3\sqrt{7}$, consequently $\cot\frac{C}{2} = \frac{3}{\sqrt{7}}$ and $\therefore \cos\frac{C}{2} = \frac{3}{4}$. But $\cos C = 2\cos^2\frac{C}{2} - 1 = \frac{1}{8}$. Q.E.D.

Work the following:—

20. In any triangle ABC, prove that:—

1. $a(\cos B + \cos C) = 2(b + c)\sin^2\frac{A}{2}$.

2. $(a - b)^2\cos^2\frac{C}{2} + (a + b)^2\sin^2\frac{C}{2} = c^2$.

3. $\frac{a\sin(B-C)}{b^2-c^2} = \frac{b\sin(C-A)}{c^2-a^2} = \frac{c\sin(A-B)}{a^2-b^2}$.

For other examples on relations existing between the trigonometrical relations when $A + B + C = 180°$, *see* Tod. Arts. 114, 115 and examples on p. 78, or Lock's 'Elementary Trig.,' Art. 235 and Examples on p. 194, *or* 'Loney,' Art. 127 and Exs. XX.

Example.—Show that in any triangle ABC,

$$\cos\frac{A}{2} + \cos\frac{B}{2} + \cos\frac{C}{2} = 4\cos\frac{\pi-A}{4}\cdot\cos\frac{\pi-B}{4}\cdot\cos\frac{\pi-C}{4}.$$

We must be prepared to make use of the fact that

$$A + B + C = \pi, \frac{A+B+C}{2} = \frac{\pi}{2}, \text{ or } \frac{A+B+C}{4} = \frac{\pi}{4}$$

By actually trying, it will be found easier to work with the right-hand side. The solution we give simply depends on the formula for adding two cosines.

$$4\cos\frac{\pi-A}{4}\cdot\cos\frac{\pi-B}{4}\cdot\cos\frac{\pi-C}{4}$$

$$= 4\cdot\cos\frac{B+C}{4}\cdot\cos\frac{A+C}{4}\cdot\cos\frac{A+B}{4}$$

$$= 2\cos\frac{B+C}{4}\cdot\cos\frac{A+C}{4}\cdot 2\cos\frac{A+B}{4}$$

$$= \left[\cos\frac{A+B+2C}{4} + \cos\frac{A-B}{4}\right]\cdot 2\cos\frac{A+B}{4}$$

$$= \left[2\cos\frac{A+B+2C}{4}\cdot\cos\frac{A+B}{4}\right] + \left[2\cos\frac{A-B}{4}\cdot\cos\frac{A+B}{4}\right]$$

$$= \left(\cos\frac{\pi}{2} + \cos\frac{C}{2}\right) + \cos\frac{A}{2} + \cos\frac{B}{2}$$

$$= \cos\frac{A}{2} + \cos\frac{B}{2} + \cos\frac{C}{2}.$$

Example.—Show that

$$\left(1 + \cos\frac{\pi}{8}\right)\left(1 + \cos\frac{3\pi}{8}\right)\left(1 + \cos\frac{5\pi}{8}\right)\left(1 + \cos\frac{7\pi}{8}\right) = \frac{1}{8}.$$

Now $\cos 2A = 1 - 2\sin^2 A = 2\cos^2 A - 1$, but the student will find it more useful, on the whole, to become familiar with the fact that $1 + \cos 2A = 2\cos^2 A$, and $1 - \cos 2A = 2\sin^2 A$, since the expression 1 + cosine and 1 − cosine occur so frequently. The left hand of the given equation

$$= 2\cos^2\frac{\pi}{16}\cdot 2\cos^2\frac{3\pi}{16}\cdot 2\cos^2\frac{5\pi}{16}\cdot 2\cos^2\frac{7\pi}{16}$$

$$= \left(4\cos\frac{\pi}{16}\cdot\cos\frac{3\pi}{16}\cdot\cos\frac{5\pi}{16}\cdot\cos\frac{7\pi}{16}\right)^2,$$

and observing the angles, we get, by taking the cosines two at a time,

$$\left[2\cos\frac{\pi}{16}\cdot\cos\frac{7\pi}{16}\times 2\cos\frac{3\pi}{16}\cdot\cos\frac{5\pi}{16}\right]^2$$

$$= \left[\left(\cos\frac{\pi}{2} + \cos\frac{3\pi}{8}\right)\left(\cos\frac{\pi}{2} + \cos\frac{\pi}{8}\right)\right]^2 \quad \left[\cos\frac{\pi}{2} = 0\right.$$

$$= \cos^2\frac{3\pi}{8}\cdot\cos^2\frac{\pi}{8} = \frac{1}{4}\left(2\cos\frac{3\pi}{8}\cdot\cos\frac{\pi}{8}\right)^2$$

$$= \frac{1}{4}\left(\cos\frac{\pi}{2} + \cos\frac{\pi}{4}\right)^2 = \frac{1}{8}.$$

The student should now work some of the examples which he will find after the Articles mentioned above. In addition we give the following, solutions to some of which we shall give next month:—

21. Show that in any triangle ABC,

$$\sin\frac{A}{2} + \sin\frac{B}{2} + \sin\frac{C}{2} = 1 + 4\sin\frac{B+C}{4}\cdot\sin\frac{C+A}{4}\cdot\sin\frac{A+B}{4}$$

22. Show that

$$\cos\frac{\pi}{16} + \cos\frac{3\pi}{16} + \cos\frac{5\pi}{16} + \cos\frac{7\pi}{16} = \frac{1}{2}\operatorname{cosec}\frac{15\pi}{16}.$$

23. If the vertex, A, of a triangle ABC is joined to any point, D, of the base, show that—

$$BC\cot ADC = DC\cot B - BD\cot C.$$

24. In any triangle if $\tan\frac{A}{2} = \frac{5}{6}$, $\tan\frac{B}{2} = \frac{20}{37}$, find $\tan\frac{C}{2}$ and prove that in this triangle $a + c = 2b$.

Geometry.

Solution to Ex. 8 (*February*).—The problem is, to find a point, say R, fig. 1., on AB, such that the angle PRQ is a maximum. To find this particular point we shall have to adopt a particular construction. Now we might here give the construction at once, but it is doubtful whether such a proceeding would benefit a student. Even at the risk of appearing lengthy we shall try to indicate a definite line of reasoning. In such problems, where a particular

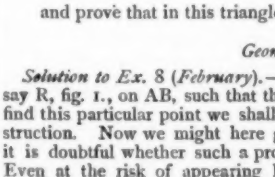

Fig 1

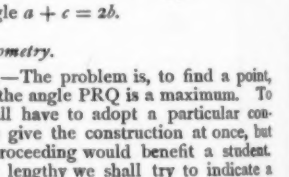

Fig 2

construction is required, it is generally best to suppose that the desired result has been obtained, then, by observing certain relations which exist, we shall be led to the necessary construction. For suppose that R, fig. 1, is the proper point, then we must prove that the angle PRQ is bigger than, say, PR^1Q. These two angles, standing on PQ, suggest a circle through P, Q, R. If R^1 were on this circle, the angles would be equal; if it were outside, then PRQ would be bigger than PR^1Q (this can be readily proved). We have therefore to arrange that every point (such as R^1) on AB shall be without the circle through PQR, or, in other words, we have to draw a circle through P and Q to touch AB; the point of contact will be the required point. If such a circle were drawn and PQ produced to C, then $CR^2 = CQ.CP$. Having made all the observations the solution will be as follows:—

Produce PQ to C, fig. 2, and find CR, so that CR^2 = the rectangle CQ.CP (II. 14); then R is the required point. At R erect a perpendicular to AB, and bisect PQ at right angles. These two perpendiculars meet at O, the centre of the required

circle, which can now be drawn with CR as radius. Join P and Q to R, and to any other point R^1 on AB, then the angle PRQ is bigger than PR^1Q.

Proof.—The angle PEQ = angle PRQ (III. 21), but the angle PEQ is greater than the interior angle PR^1Q, therefore PRQ is greater than PR^1Q.

[N.B.—CR might have been set off to the right of C, this would have given R for angles on the other side of PQ.]

Work the following riders:—

10. A line of given length moves between two lines at right angles to each other, having one of its ends on each of them; find when its centre is at a minimum distance from a given line.

11. A and B are the extremities of a given arc of a circle; show how to find the position of a point C on the arc, such that the chords AC and BC may be together equal to a given straight line.

If D be the middle point of the arc, show that the length of the given straight line must not exceed twice the chord AD.

12. Two unequal circles intersect at A; show how to draw a straight line PAQ, cutting the one circumference in P and the other in Q, so that PA may equal AQ.

HONOURS PHYSIOGRAPHY NOTES.

BY A. M. DAVIES, B.SC. (LOND.), F.G.S.,
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Modern Deposits and Geological Strata.

THE study of the floor of the modern ocean, in the 'Challenger' and other expeditions, shows that while the same kind of deposit extends over very large areas, yet in some part or other there are now forming deposits probably comparable to any known as constituting the geological formations. It has often been said, in fact, that some of the existing deep-sea deposits, especially Red Clay and Radiolarian Ooze, are unparalleled among the rocks; though numerous recent discoveries tend to refute this view. Along the coast-lines the deposits are even more varied, but here their nature is more immediately dependent on local circumstances, in respect both of the derivation of material and of the influence of currents; hence a shore-deposit of a particular kind will persist over a very much smaller area than a deeper-water deposit.

Some important consequences of these facts have recently been insisted on by Mr. Teall. In an address to the British Association, he has pointed out that if, for example, depression of an area is taking place, such a deposit as Globigerina Ooze will gradually extend over regions where previously Blue Mud was being laid down. The change from the Blue Mud to the Ooze would not be simultaneous over the whole region, but only along a line generally parallel to the original sea-margin, since the Blue Muds form along a regular zone around the coasts; the change would take place later and later, as we pass nearer and nearer to that margin. The same principles must hold for the geological formations, and a well-marked line of division between a clay, representing possibly a consolidated Blue Mud, and a limestone or chalk, representing Globigerina Ooze, need not indicate a real time-level. It will, in fact, only do so if the line of outcrop of the beds (that is the line along which their junction can be traced at the surface) happens to be generally parallel to the old coast line. The truth of this view is proved by the evidence of fossils as to the age of beds: thus the Gault is a very well-marked and thick clay in the south-east of England, and the beds above and below it are constant in character for a long distance; yet by the evidence of the successive series of fossils found in these beds, it has been shown that both the beginning and the end of the deposition of Gault clay took place much earlier in some parts of the district than in others. In the case of some formations, on the other hand, it has been pointed out that the age and character alike seem to persist from one end of Britain to the other. This is not surprising if we look at a map of modern oceanic deposits and see how easily an area as large as Britain might be covered by any but the very smallest of the areas over which a particular deposit is now being laid down. Finally, strata resembling existing coast-deposits are the least persistent of any.

With regard to the identification of deposits like the modern ones among the geological formations, we may give the following:—

Blue Mud.—Several examples of clays comparable to this were given last month.

Green Mud and Sand.—These owe their colour to the mineral glauconite, often occurring as casts of foraminiferal shells. Glauconite grains in this form were found long ago by Ehrenberg in rocks in Russia, now known to belong to the lowest Cambrian; they are also abundant in other formations, particularly in the strata that come below the Chalk in England (Upper and Lower Greensand).

Volcanic Mud and Sand.—Similar deposits are well known under the name of 'ash,' especially in the Ordovician, Devonian, and Carboniferous formations of England, and in the Triassic also in the Alps. It is a remarkable fact that in many of these cases the volcanic deposits are found associated with coral deposits, just as they are at the present day in Torres Straits, the West Indies, and elsewhere.

Coral Mud and Sand.—Along with the last, and also in the Silurian and Oolitic of England.

Pteropod Ooze.—This is perhaps the most doubtfully represented of modern deposits among the older rocks; but as Pteropods are probably a very recent group, this is not surprising. There seem, however, to be some Pteropod oozes in the Tertiary beds of the Mediterranean basin.

Globigerina Ooze.—The identity of the Chalk with this has long been a matter of dispute. The most recent researches—those of Dr. Hume—give no countenance to the view that Chalk was a shallow-water deposit; there can, therefore, be no further objection to its identification as Globigerina Ooze. Other examples are known in the Mediterranean Tertiaries.

Diatom Ooze is also known in the last-mentioned formations.

Radiolarian Ooze.—The well-known Barbados Earth of late Tertiary age was for long the only instance, and its deep-sea origin was long but unsuccessfully disputed by the upholders of the theory of the Permanence of Ocean Basins. More recently similar deposits have been found in other formations, particularly the Ordovician.

Red Clays also are known in the Tertiaries of the Mediterranean. It is possible, though not certain, that they may also be represented by certain slaty rocks found in the Ordovician of Cumberland and Scotland. The reasons for so identifying these rocks are:—(1) Like the Red Clay, they were certainly of very slow formation, as they are equivalent in time to much greater thicknesses of strata elsewhere. (2) Almost the only fossils found in them belong to the extinct group of Graptolites, and these are often very abundant: it is probable that Graptolites were pelagic forms, and their skeletons seem to have been horny, and so not liable to be dissolved as calcareous ones are known to be in cases where modern Red Clay is formed. (3) They are associated with Radiolarian deposits, which are now found on the parts of the ocean floor that most nearly approach in depth to the Red Clay areas.

Movements of Elevation and Depression.

The question of the recent elevation or depression of the earth's surface in various regions has attracted much attention from geologists in the last few years. Prof. Prestwich, in a recent paper on the 'Rubble-drift' of the South of England, has endeavoured to correlate together a number of superficial accumulations, which he regards as formed during the last emergence of the country from beneath the sea—an emergence which he considers to have been very sudden, and to have been preceded by only a short period of submergence. The paper in which these views were expressed is so elaborate a one, dealing with such a variety of matters, that it has not been adequately criticised yet; the tendency of criticism, however, is to assert that under the name of 'rubble-drift,' Prof. Prestwich has included a number of deposits that are not all of the same origin.

At the same time, other geologists have been attacking the doctrine of a considerable submergence of Britain in Pleistocene times altogether. The rubble-drifts may, to a great extent, be claimed as of sub-aerial origin, but the main evidence for a great submergence has been the occurrence of recent marine shells at places now more than 1,000 feet above sea-level, as at Moel Tryfaen (Carnarvonshire), near Macclesfield, and near Oswestry. A number of English geologists have now come to the opinion that the animals to which these shells belong never lived where the shells are now found; but that the shells were brought to their present position by an ice-sheet of great thickness that travelled down the Irish Sea, and after pushing much material from the sea-bottom before it, or carrying it frozen into its substance, was stopped in its course by the North Wales mountains. The deposits in which the shells are found are supposed to have been left on the melting of the end of the ice-sheet. This view may at first sight seem very far-fetched, but it is supported by a great amount of detailed evidence, and seems to be gaining ground. On the other hand, it is rejected by some competent judges.

As mentioned in *Honours Physiography*, Prof. Suess and others are inclined to attribute all apparent vertical elevations of the land to subsidence of the sea-level. According to this view, *elevation* only occurs in connection with *folding*. It is asserted that there is

no clear evidence of a vertical movement of the earth's crust, unaccompanied by the formation of folds. Prof. Suess has critically examined the evidence of the supposed upheaval of the Chilian coast, and finds that there is no ground for accepting it. He accounts for extensive apparent emergences by the sinking of great areas of the sea-floor. Thus the emergence of much of Western Europe he would correlate (in part at least) with the origin of the North Atlantic depression, both having gradually occurred in the course of the Tertiary period.

The Distribution of Volcanoes.

The connection of volcanoes and earth-movements has always been recognised. The association of modern volcanoes with sea-margins is also a familiar fact, and some causal connection of the two has been thought possible. It is now being recognised that the distribution of volcanoes and of sea-margins may be the effects of a single cause, instead of one being the cause of the other. Professors Suess and Lapworth have both insisted on the association of volcanoes with the lines of greatest stress in the formation of earth-folds. The most striking case is that of the Pacific Ocean; this ocean is margined by a series of curves, whose convexity is towards the ocean. They either form the actual coast-line, as on the American side, or a series of islands like the Kuriles and Japan. In the former case the coast is backed by mountain ranges, the Rockies and Andes; and the latter may be regarded as submerged mountain ranges, as they rise up abruptly from very great depths of the sea. Measured in this way, Japan consists of the summits of a mountain range much higher than the Himalayas. This series of curves bordering the Pacific is regarded as a series of earth-waves by Prof. Lapworth, and he points out that all along this margin we have abundant active volcanoes, and that volcanic activity is greatest where there is the steepest fall in level between the mountains and the ocean-depths, that is where the strain of folding is greatest.

The association of volcanoes with earth-folding is also shown by the areas of extinct volcanoes that border the course of the Alps (Auvergne, the Eifel, Bohemia, etc.), and there is a good deal of geological evidence of a similar association in past periods.

ORGANIC CHEMISTRY NOTES.

By J. T. Hewitt, M.A., D.Sc., PH.D.,
Professor of Chemistry, People's Palace Technical Schools.

When a hydrogen atom of a saturated fatty hydrocarbon is replaced by a hydroxyl group, the resulting compound is known as an alcohol; on the other hand a similar replacement of hydrogen in the case of an aromatic derivative leads to a phenol. These two classes of compounds differ very considerably from one another; a phenol, though not a true acid, approaches much more nearly to the acidic character. A good example of this is seen in the behaviour of the phenols towards the metals of the alkalies. Ordinary phenol, or carbolic acid, C_6H_5OH, dissolves readily enough in potash or soda, forming a solution of potassium or sodium phenolate; whilst in order to produce sodium alcholate it is necessary to dissolve the metal sodium in absolute alcohol; and the solution of sodium aicoholate so obtained is at once decomposed by water, yielding the alcohol and caustic soda. We thus see that the action of water on sodium alcoholate is very different to what it is in the case of sodium phenolate, which is actually found in presence of water.

$$C_2H_5ONa + H_2O = NaOH + C_2H_5OH,$$

whilst $$C_6H_5OH + NaOH = H_2O + C_6H_5ONa.$$

Although the phenols behave in this way, as if they were weak acids, yet their alkaline salts are usually decomposed by carbonic acid, a carbonate of the metal being obtained whilst the phenol is regenerated. Their acid character can, however, be greatly strengthened by the introduction of negative groups, especially in the ortho and para positions; thus the strong acid, picric acid, is trinitro phenol, $C_6H_2(OH)(NO_2)_3$ 1 : 2 : 4 : 6.

In another respect the phenols show a difference in properties when compared with the alcohols,—they do not yield hydrocarbons by taking away the elements of water; neither are they oxidised by nitric acid to aldehydes, ketones, or acids; they yield instead nitro substitution derivatives.

The homologues of the phenols show very similar properties, yielding substitution products with great ease. These higher members of the phenol series show a peculiar behaviour on melting with potash, the side chains in proximity to the OH group undergoing an oxidation to acid carboxyl groups. Thus (a) m-xylenol (OH : CH_3 : CH_3 = 1 : 2 : 4) yields o-oxy-m-toluylic acid (OH : COOH : CH_3 = 1 : 2 : 4) under these conditions; whilst the isomeric p-xylenol (CH_3 : OH : CH_3 = 1 : 2 : 4) gives o-oxy-p-toluylic acid (COOH : OH : CH_3 = 1 : 2 : 4).

Although the phenols show so many deviations from the behaviour of the primary and secondary alcohols, still there is a certain analogy between them and the tertiary alcohols. Menschutkin examined in much detail the reaction which takes place when alcohols are heated with organic acids. In this case an ethereal salt is formed to a certain extent, but this reaction is a reversible one; for if an ethereal salt is heated with water a certain amount of alcohol and acid are regenerated. In such a case as this it was to be expected that the amount of ethereal salt formed and the rate of its formation would depend to a certain extent on the alcohol and acid employed, and this was found to be the case when actual experiments were made. Menschutken found that equal molecules of acetic acid and methyl alcohol when heated together in a sealed tube to 154° yielded 55·59% of the methyl alcohol as methyl acetate when the heating had been continued for one hour; if the heating were continued for an indefinite period as much as 69·59 of the methyl alcohol might be acted upon, but never any more. He termed the percentage amount of an alcohol so converted into ethereal salt the initial velocity of etherification of the alcohol if the heating had only continued one hour; whilst the larger quantity which might be produced by continuous heating was styled the limit. For acetic acid and the primary alcohols, Menschutkin obtained the following numbers:—

Alcohol.	Initial Velocity.	Limit.
C_2H_5OH	46·81	66·57
C_3H_7OH	46·50	66·85
C_4H_9OH	46·85	67·30
$C_5H_{11}OH$	46·57	72·34

The numbers obtained in the corresponding cases of the secondary and tertiary alcohols were considerably lower, isopropyl alcohol having an initial velocity of 26·53, and isobutyl alcohol of 22·59; whilst trimethyl carbinol (tertiary butyl alcohol) had an initial velocity of only 1·43, and ethyl dimethyl carbinol ·81.

When Menschutkin heated phenols with acetic acid he found that the numbers were comparable in magnitude with those obtained in the case of the tertiary alcohols (·55 to 1·45); the limiting values were also small, only 8·64% of phenol and 9·46% of thymol being capable of conversion into the corresponding acetates by heating with acetic acid. It should be noted here that benzyl alcohol, $C_6H_5.CH_2OH$, although an aromatic compound, is no phenol, but a primary alcohol, and as such has an initial velocity of etherification of 37·87.

One sees from the preceding remarks that the preparation of acetyl derivatives of the phenols will not be carried out in practice by heating with acetic acid; acetyl chloride or acetic anhydride with or without the addition of fused sodium acetate are employed instead. The benzoates of the phenols can be most readily prepared by the method of Schotten and Baumann. The phenol is dissolved in the calculated quantity of dilute soda, and the theoretical quantity of benzoyl chloride added in the cold. The mixture is then well shaken until the smell of benzoyl chloride has disappeared, the benzoate separating in the solid condition; it can then be filtered off, washed, and recrystallised. A similar method can be employed in the preparation of the benzene sulphonates, benzene sulphonyl chloride, $C_6H_5SO_2Cl$, being substituted for the benzoyl chloride.

The amido phenols, $C_6H_4(OH)(NH_2)$, are of considerable technical importance. The ortho compound when oxidised yields complicated dye-stuffs, and readily furnishes internal condensation products owing to the ortho position of the amido and hydroxyl groups; formic acid, for instance, gives methenyl-ortho-amido phenol.

$$C_6H_4\begin{cases}NH_2\\OH\end{cases} + H.COOH = 2H_2O + C_6H_4\begin{cases}N\\O\end{cases}CH.$$

Meta-amido phenol and its diethyl derivative, $C_6H_4N(C_2H_5)_2OH$, are prepared respectively by fusion of meta-amido- and diethyl-meta-amido-benzene sulphonic acids with alkali; they may also be prepared by condensation of resorcin with ammonia or diethylamine. Merz also prepared a phenyl-meta-amido phenol by heating aniline with resorcin and calcium chloride, whilst Calm found that by substitution of zinc chloride for calcium chloride a second molecule of aniline could react, diphenyl-meta-phenylene diamine being produced. The reactions in the two cases can be expressed by the equations—

$$C_6H_5NH_2 + C_6H_4(OH)_2 = H_2O + C_6H_5.NH.C_6H_4.OH$$

and $$C_6H_5NH_2 + C_6H_5.NH.C_6H_4OH = H_2O + C_6H_4(NH.C_6H_5)_2.$$

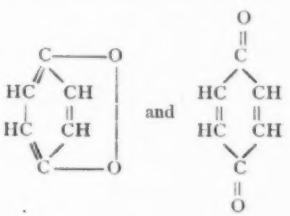
Meta-amido phenol and its substitution products are now largely employed in the manufacture of the colouring matters known as rhodamines and pyronines.

Para-amido phenol is remarkable for the ease with which it can be oxidised to quinone, $C_6H_4O_2$; bleaching powder acts on it, giving quinonechlorimide, $C_6H_4O(NCl)$.

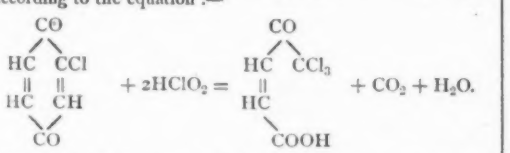
The dioxybenzenes are, of course, three in number, the ortho, meta, and para compounds, being known as pyrocatechin, resorcin, and hydroquinone respectively; all these react with ferric chloride. With this reagent pyrocatechin gives a green coloration, which is turned violet-red on addition of soda: resorcin gives a dark violet with the iron salt; this gets nearly black; whilst hydroquinone is merely oxidised to quinone (yellow needles). Resorcin is the starting-point of many colouring matters, and is prepared on the large scale by melting meta or para benzene disulphonic acid with potash. It is rather remarkable that the para acid should yield a meta-dioxy compound under these circumstances, molecular change taking place; it may be mentioned that this occurs in other cases of potash fusion, all three—bromo, benzene, sulphonic—acids yielding resorcin in this way. When resorcin is heated with phthalic anhydride it gives fluorescein; it furnishes many oxy-azo compounds, and is converted by nitrous acid directly into dye-stuffs, which will be referred to later on. Hydroquinone is prepared indirectly from aniline, which is oxidised by chromic acid to quinone, $C_6H_4O_2$, and this compound then reduced to hydroquinone, $C_6H_4(OH)_2$, by means of sulphurous acid. To express the ready way in which hydroquinone is oxidised to quinone, the structural formula

was given to the later substance; this has now been altered to

The two formulæ may be written graphically in the following way:—



The second of these formulæ represents the reactions of quinone best. Chlorous acid acts on quinone, giving trichloracetylacrylic acid, according to the equation:—

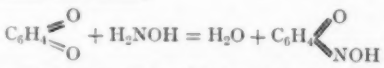


$$+ 2HClO_2 = \qquad + CO_2 + H_2O.$$

It will be noticed that the first action is chlorinating, monochlorquinone being produced, and then decomposed according to the above equation. The constitution of the acid formed was proved by Kekulé and Strecker, who found that it was decomposed on warming with baryta water, giving chloroform and maleïc acid.

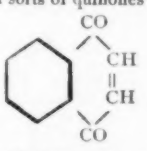
$$C_3H_3Cl_3O_3 + H_2O = C_4H_4O_4 + CHCl_3.$$

Again, quinone reacts with hydroxylamine, forming a monoxim after the manner of a ketone,

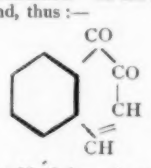


the quinone-monoxim so produced being identical with the nitroso phenol obtained by Baeyer and Caro by boiling nitroso-dimethyl aniline, $(CH_3)_2N.C_6H_4.NO$, with caustic soda, or by acting with nitrous acid or phenol.

Besides such paraquinones which have the two carbonyl groups in the para position, orthoquinones are also known, whilst metaquinones do not seem capable of existence. In the naphthalene series both sorts of quinones are found, thus:—

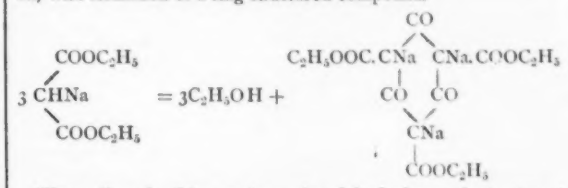


α-Naphtha quinone.



β-Naphtha quinone.

The trioxybenzenes have next to be considered; they are also three in number. Pyrogallol, or pyrogallic acid, has the three hydroxyl groups in the consecutive position, and is usually obtained by heating gallic acid, $C_6H_2(OH)_3COOH$. Phloroglucin, the symmetrical compound, is produced by heating many resins with potash; its constitution is proved by its synthetical formation. Baeyer found that when sodium malonic ether is heated to 140–150°, alcohol splits off, with formation of a ring-structured compound.

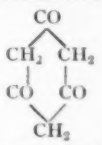


$$= 3C_2H_5OH +$$

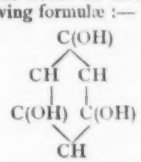
The sodium in this may be replaced by hydrogen by treatment with sulphuric acid; the carboxylic ether so obtained can be hydrolysed, and this on distillation with lime loses three molecules of carbon dioxide, and gives phloroglucin.

$$C_6H_3O_3(COOH)_3 = 3CO_2 + C_6H_6O_3.$$

From the method of formation, one would be inclined to give phloroglucin the first of the two following formulæ:—



Triketohexa methylene.



Trihydroxy benzene.

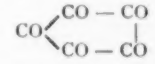
There are reactions of phloroglucin which point to the first of these formulæ, such as the formation of a trioxin with hydroxylamine; on the other hand, it forms metallic compounds and a trimethyl ether, $C_6H_3(OCH_3)_3$, insoluble in alkalies. We are thus brought to the conclusion that one and the same compound, phloroglucin, may behave as if it had two different formulæ, an example of *tautomerism*.

Amongst the higher substituted phenols, hexa-hydroxy benzene, $C_6(OH)_6$, is of great interest, as its potassium salt is the black compound of explosive properties found in the manufacture of potassium. The constitution of this substance was cleared up by Nietzki and Benckisser. Nitrous acid acts on quinol, giving a dinitro-dihydroxy quinone, $C_6(OH)_2(NO_2)_2O_2$, known usually as nitranilic acid. On reduction this yields diamido-tetra-hydroxy benzene, $C_6(NH_2)_2(OH)_4$, the hydrochloride of which, oxidised by strong nitric acid, gives a substance whose analysis points to the formula $C_6H_{16}O_{14}$. This is really the octohydrate of triquinoyl, C_6O_6 (or $(CO)_6$), the triquinone of the benzene series, as is seen by the fact that reduction with stannous chloride leads to hexa-hydroxy benzene, $C_6(OH)_6$. The potassium carboxide, prepared by Liebig by heating potassium in a stream of carbon monoxide, is simply the potassium salt of this phenol.

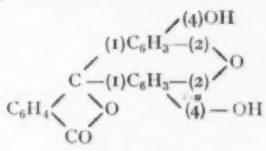
The so-called potassium croconate may be obtained by boiling triquinoyl with water, and adding potash to the residue,

$$C_6O_6 + H_2O = CO_2 + H_2C_5O_5.$$

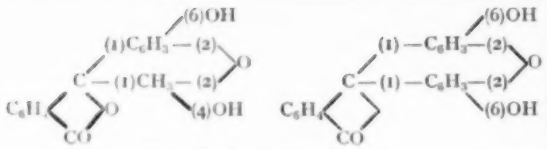
By oxidation of croconic acid, leuconic acid, $C_5O_5.4H_2O$, is obtained; since this substance gives a pentoxime $C_5(NOH)_5$, it must be



Recent Work.—Two interesting papers on the constitution of fluorescein and its derivatives appear in the first number of the *Berichte* for the current year. The first of these is by Græbe, who holds that the hydroxyl groups in fluorescein are ortho to the carbon atom of the phthalic acid residue, or, at any rate, that one of the two such groups is, instead of occupying the para position in the usually accepted formula. Thus we have—

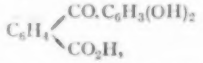


Usual formula.



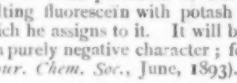
Graebe's alternative formulae.

The reason Graebe gives for this proposed alteration of formula is that the mono-resorcin phthalein,

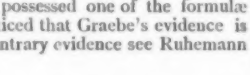


will not yield a dioxy-arthra quinone under the influence of dehydrating agents, so that he infers that the two hydroxyl groups in this compound must be in the way of the COOH group acting. A mono-resorcin phthalein of this constitution could only result by melting fluorescein with potash if it possessed one of the formulæ which he assigns to it. It will be noticed that Graebe's evidence is of a purely negative character; for contrary evidence see Ruhemann (*Jour. Chem. Soc.*, June, 1893).

The second paper on fluorescein constitution is by Nietzki and Schroter; they show that fluorescein yields a double series of derivatives some corresponding to the lactone formula, others to the quinonoïd.



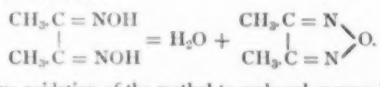
Lactone formula.



Quinonoïd formula.

Fluorescein gives two diethyl ethers,—a coloured one derived from the second formula, and a colourless derived from the first. The coloured substance is derived by the action of ethyl bromide on the sodium salt of fluorescein; but by varying the conditions a diethyl ether which is colourless may be obtained at the same time, together with certain amounts of two monoethyl ethers, one of which is ethylated with respect to a carboxyl group, the other with respect to hydroxyl. The difference of colour of the two diethyl ethers is of great interest, as some time back it was shown that phenolphthalein is a similar example; it is itself colourless, whilst the salts are coloured, the free substance being phenolic in character, whilst the salts are derived from a quinonoïd acid, since it is only the salts which re-act with hydroxylamine to form an oxim.

Wolff gives an account of several furazan derivatives, dimethylfurazan being obtained from the dioxim of diacetyl by heating with water in a tube to 160°.



Successive oxidation of the methyl to carboxyl groups has led to methylfurazan carboxylic acid and furazan dicarboxylic acid. It was found impossible to split carbon dioxide from the latter and obtain the free furazan, $C_2H_2N_2O$.

Questions—Advanced.—1. Indicate the relationship existing between succinic, tartaric, and malic acids. How can malic acid be converted into succinic acid, and succinic acid into malic acid? 2. How can urea be artificially prepared? How can you show that it contains nitrogen? Why is it sometimes called carbamide? 3. Describe the various methods by which salicylic acid is manufactured, and mention the uses to which it is applied. 4. Describe the process for obtaining the primary monamines containing methyl and ethyl. How would you prepare tetra-ethyl-ammonium hydroxide?

Honours.—1. Mention reactions by which hydroxylamine may be obtained. Give as full an account as you can of its use as a reagent in studying carbon compounds, and of the general characters of the substances thus formed. 2. Illustrate the meaning of the word 'tautomerism,' by reference to nitrosophenol and phloroglucin. How are these substances prepared? 3. How is ethyl aceto-acetate prepared? Show the course of the reactions by which the more complex ketones and acids may be obtained from its derivatives. 4. On what facts are the now usually received formulæ for quinone based?

SCIENCE NOTES.

ELECTRICITY AND DOUBLE REFRACTION.—That there is a close parellelism between light and electricity has in recent years been clearly established, and that the latter as well as the former is connected with the luminiferous ether is becoming more and more probable. A recent discovery by Herr K. Mack, bearing on this resemblance, is detailed in *Wiedmann's Annalen*, consisting of a demonstration, that as light waves undergo double refraction when a beam is passed through Iceland spar, so electric waves show similar behaviour when caused to pass through wood. Mack's apparatus is modelled on the well-known arrangement of Nicoll prisms, so placed that their principal planes are crossed, when no light can be passed through them, except when a doubly refracting substance is placed between them. Instead of the Nicoll prisms two concave mirrors of the form arranged by Hertz are used, their focal lines being crossed. Mack inserts between them a block or plate of wood, nearly a foot thick, with its fibre at an inclination of 45° to each of the focal lines. On passing the current, the sparks which were extinguished on crossing the two focal lines re-appear when the wood is inserted as described. The experiment shows that waves of electric force are transmitted in a different manner accordingly as they vibrate across or along the fibre of the wood.

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VARIATION IN PLANTS AND ANIMALS.—The second of the new series of meetings for discussion of scientific questions of importance recently inaugurated by the Royal Society was held at Burlington House on February 28. The subject chosen was the very comprehensive one of Variation, and it was introduced by Prof. Weldon, F.R.S., who brought forward the advantages of dealing with the question statistically. He gave an account of the work of a committee of the Society, which turned on the influence of a certain variation of size of a particular dimension on the death-rate of certain crabs. In the course of the investigation more than 8,000 crabs of various ages had been measured. The outcome of the investigation was that a small variation in a particular direction was associated with a perceptible increase in the death-rate.

The discussion was a very animated one, contributions to it being made, among others, by Messrs. Thiselton-Dyer, Ray-Lankester, and Bateson.

The great attention that is being given to this subject at home finds an echo abroad. The University of Indiana has undertaken an extensive research in this direction by deciding to establish an inland biological station on one of the lakes of Northern Indiana. The investigations at present proposed are to determine the extent of variation in the non-migrating vertebrates, the kind of variation, and its quantity and direction. The experiments will extend over a number of years. It is hoped that much valuable information will be obtained, not only on variation under ordinary conditions of life, but on the modifications that can be induced by change in environment. The director of the new station will be Prof. Carl H. Ergenmann.

***

VARIETIES OF CHLOROPHYLL.—Etard, who has for some years past been engaged in researches in the nature of the green colouring matters of plants, has in a recent paper pointed out that chlorophyll may be more or less blue, green, or yellow, according to the plants from which it is prepared. He finds, further, that the different chlorophylls he identifies undergo very different changes on their decomposition. To some he attributes the formation of essential oils; to others various carbohydrates, tannins, &c. The different bodies passing under the name of chlorophyll contain very different amounts of oxygen.

***

ALUMINA IN PLANTS.—Considering the bulk of alumina present in cold soils, it is rather surprising that so few instances are known of its occurrence in plant tissues. Hitherto it has been chiefly associated with a small group of plants belonging to the vascular cryptogams. Berthelot and André have recently shown that it is present in many annual plants which have roots that penetrate deeply into the soil. The bulk of the alumina absorbed is retained by the roots, but a certain quantity reaches the leaves. The plants investigated were the roots of lucerne and convolvulus and the leaves of the lupin and the lime. The quantity found varied from 0·5 per cent. in the roots to 0·0025 per cent. in the leaves.

***

BORON STEEL.—A curious alloy of steel and boron has been investigated by Messrs. Moissan and Charpy. It is prepared by heating pure amorphous boron with reduced iron in the proportion of 1:9 and adding the resulting boride to melted soft steel, the mixture being subsequently twice fused. In its physical properties it

closely resembles soft steel, except with regard to its tenacity, which equals that of hard steel. It is malleable and easily cut by filing.

***

GLYCOLYTIC FERMENT OF THE PANCREAS.—The sugar-destroying power of the pancreas has been for some time the subject of much investigation by physiologists. In a recent paper, Lépine claims to have proved the power to be due to a definite *enzyme* or ferment, which exists in the condition of a *zymogen* in the tissue of the gland.

***

DETECTION OF FIRE-DAMP IN MINES.—An application of the principles of acoustics to so practical a question as the detection and even quantitative estimation of fire-damp in mines seems at first sight extremely unlikely. Yet a new instrument has been devised which the inventor claims will satisfactorily do both. The *formeophone* is the name given to it by its introducer, M. Hardy. It is well known that when a pipe, such as an organ pipe, is made to sound by a column of air vibrating inside it, the pitch of the note depends very largely on the density of the vibrating air or gas. If the gas be a light one such as hydrogen, the note will be much shriller than if it be a fairly heavy one, such as air. M. Hardy, by means of the formeophone, compares the density of pure air with that of the mine. He takes two small organ pipes exactly alike and connects one with the air of the mine and the other with pure air. If the air of the mine contains fire-damp, the difference in the density causes the note to differ from that yielded by the tube in which air is vibrating, and the amount of difference will be in proportion to the fire-damp present. M. Hardy's apparatus has been submitted to a committee of the French Academy of Science, and has been favourably reported on.

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GREEN GLASS IN FERN CULTIVATION.—For the last fifty years the authorities at Kew Gardens have held that in the growing of ferns green light was most advantageous to the plants, and consequently the houses devoted to ferns have been glazed with glass coloured faintly green. The material is now being abandoned for ordinary white glass, as it has been proved by careful experiments that ferns do not require the green light, but do very well with ordinary illumination.

NOTES ON THEORETICAL MECHANICS.

ADVANCED AND HONOURS STAGES.

BY F. CASTLE, M.I.M.E.

AN attempt will be made in the following notes to assist those who are preparing for the Examinations of the Department of Science and Art in the above stages. It is hoped that they will also be found useful for examinations other than those named. To this end the student is advised to obtain the necessary text-books; to carefully read the chapters bearing on the subject matter referred to; and to work out as far as possible the examples to be found at the end of each chapter.

In addition, questions chiefly selected from past examination papers will be given, answers to these will be furnished in many cases, and hints and solutions as far as seem to be desirable and necessary. Also any questions sent to the Editor will be answered in these columns as far as space will permit.

A large number of good text-books are to be obtained, perhaps the following will be found the most suitable :—

'Dynamics and Hydrostatics,' by Pinkerton, published by Blackie's. 'Mechanics and Hydrostatics,' by Loney; Cambridge University Press. 'Theoretical Mechanics,' by Thornton; Longman's.

Reference may also be made with advantage to 'Theoretical Mechanics,' and 'Practical Mechanics,' by Twisden, published by Longman's.

Any of the above will be found suitable for the examination in 'Solids'; for the examination in 'Fluids,' the following :—

'Hydrostatics and Pneumatics,' by Pinkerton; Blackie's. 'Hydrostatics,' by Greenhill.

The definitions given in the first few pages of any of the books referred to should be very carefully read; in particular, the followiug may be noted :—

Force (which may be of divers kinds, such as tension or pressure, gravity, friction, etc.) is whatever changes, or tends to change, the motion of a body by altering either its direction or its magnitude.

Measure of a force is the momentum it produces in its own direction in unit of time; hence, if F denote the force acting on a body of mass M lbs. during a time t, and if U be the initial and V the final velocity of the body, then $F \times t = M\,(V-U)$, or change of momentum of a body is numerically equal to the impúlse which produces it and is in the same direction, this being really a statement of the second law of motion in terms of *impulse* and *momentum*.

If the above equation t be made equal to unity, then V—U gives the alteration in the velocity for one second; hence, if f denote acceleration, we get $F = M/$. (1)

Unit of force may be expressed either as the force which creates a velocity of 1 foot per sec. in a mass of 1 lb. in each sec., or as the weight of one pound = 32·18 poundals (taking $g = 32{\cdot}18$). The former is known as the *absolute unit*, and the latter as the *gravitation unit of force*.

Hence in equation (1), if M be the mass of the body in pounds and f the acceleration in ft. per sec. per sec., then F is the force in poundals.

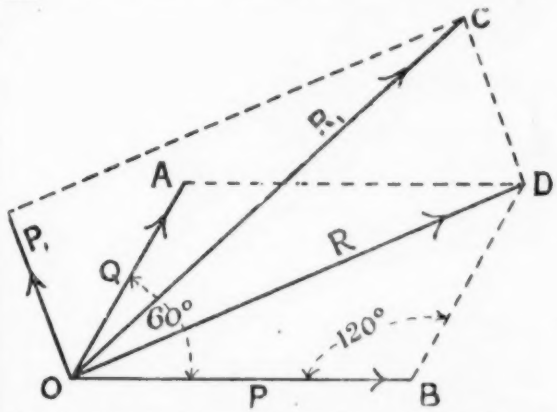
To give F in pounds, equation (1) would become $F = \frac{M}{g} \times f$.

Two other units should be carefully noted; these are—

Unit of momentum = (unit of mass) × (unit velocity).

Unit of work = (unit of force) × (unit distance).

The *specification of a force* should also be carefully made out; unfortunately this is often either ignored or overlooked by the advanced student—nearly, if not quite, as often as by the elementary. Referring to the report of the Examiner in Theoretical Mechanics for 1894, we find 'The specification of the resultant was seldom given;' other instances might be quoted, but the above will suffice to show the necessity of obtaining a clear notion of the force under consideration, and of the three elements which must be known before the specification can be made out; these are, its *point of application*, its *direction*, and its *magnitude*. When all three are known, and only then, we have the specification required. It will be noticed that a straight line may be used to represent a force; it may be drawn in any assignable direction, and the magnitude can be given by the number of units in its length; hence any physical phenomenon which is directional, such as a force, a velocity, an acceleration, etc., may be represented in the best way by a straight line.



By the aid of the fundamental proposition in Statics called the *parallelogram of forces*, we can find the resultant of any number of forces acting at a point. Thus if OA and OB represent two forces P and Q acting at the point O (where O either represents a small body or is a point in a large rigid body), the resultant, *i.e.*, a single force which would have the same effect as the two given forces combined, is represented by the line AD in direction and magnitude. It will be noted that the forces act at the point O, the direction is given by OA and OB respectively, and magnitudes by their lengths to any convenient scale.

As a numerical example, let OB = P = 3 lbs., OA = Q = 2 lbs., and OD = R, also the angle AOB = 60°, then, drawing the lines OB and OA equal to 3 and 2 units respectively on any convenient scale, and making the angle AOB = 60°, it will be found by completing the parallelogram that OD = 4·35 lbs.

By calculation $R^2 = P^2 + Q^2 - 2PQ \cos 120°$ (3)

$= P^2 + Q^2 + PQ = 4 + 9 + 6 = 19.$

$\therefore R = \sqrt{19} = 4{\cdot}3589$ lbs.

From equation (3) it is easily seen that if the angle AOB = θ,

then when θ is 0 R = P + Q = 5 lbs.,

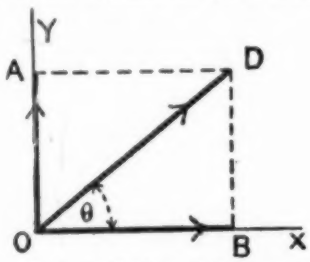
then when θ is 180° R = P − Q = 1 lb.,

when θ is 90° $R = \sqrt{P^2 + Q^2} = \sqrt{13}$ lbs.

Similarly, if a third force P be supposed to act at point O, since R represents the equivalent of P and Q, we can, by completing the parallelogram on PR, get the resultant R for the three given forces.

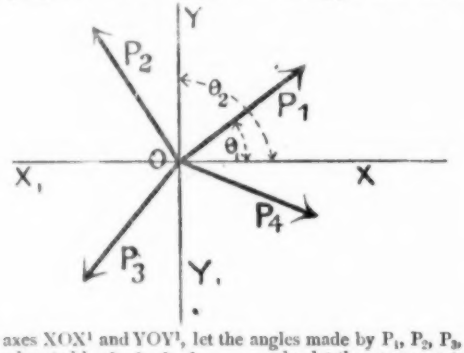
In like manner the resultant of any number of forces acting at a given point can be found. The *polygon of forces* can also be applied to find the resultant of any number of forces; thus in the figure from B, BD is drawn parallel and equal in magnitude to Q. Similarly, DC is equal and parallel to P, then the resultant is given by the line OC and the equilibrant by CO, *i.e.*, the resultant is obtained by drawing a line from the starting-point to the point finally reached.

We next consider the *resolution of a force* into two components; thus, let OD represent the given force in direction



and magnitude. It is required to find the components of OD in the directions OX and OY. Draw DB parallel to OY to meet OX at B, and DA parallel to OX to meet OY at A, then to the scale that OD represents the given forces, OB and OA to the same scale will give the magnitudes of the components respectively. It is usually convenient to make the angle BOA a right angle as shown, then OB and OA are called the *rectangular components* of the force. In this case, if the angle BOD = θ, then OB = OD cos θ, and OA = OD cos DOA = OD sin θ.

We may proceed in a similar manner if any number of forces P_1, P_2, P_3, P_4 . . . . act at a point O. Through O draw the rect-



angular axes XOX^1 and YOY^1, let the angles made by P_1, P_2, P_3, P_4 . . . . be denoted by θ_1, θ_2, θ_3, θ_4 . . . . ; also let the components in the directions XOX^1, YOY^1 be denoted by X_1, X_2, X_3, X_4 . . . . and Y_1, Y_2, Y_3, Y_4 . . . . then, denoting the sum of X_1, X_2, X_3, X_4 . . . . by ΣX, and the sum of Y_1, Y_2, Y_3, Y_4 . . . . by ΣY,

Then $\Sigma X = P_1 \cos\theta_1 + P_2 \cos\theta_2 + P_3 \cos\theta_3 + P_4 \cos\theta_4$ . . . .

And $\Sigma Y = P_1 \sin\theta_1 + P_2 \sin\theta_2 + P_3 \sin\theta_3 + P_4 \sin\theta_4$ . . . .

and the resultant R is found from the equation—

$$R^2 = (\Sigma X)^2 + (\Sigma Y)^2$$

$$\therefore R = \sqrt{(\Sigma X)^2 + (\Sigma Y)^2}.$$

Also, if θ denote the angle made by the resultant with the axis XOX^1, then $\tan\theta = \frac{\Sigma Y}{\Sigma X}$, from which θ can be found.

It will be noted that the analytical method just referred to consists in resolving each force into a horizontal and vertical component, taking the algebraic sum of all the horizontal and also of all the vertical components, thus reducing them to two acting at right angles to each other; the resultant is found by Euc. I. 47.

In making the algebraic sum, it must be carefully noticed that any horizontal component acting from left to right is considered positive, and any vertical component acting upwards is also positive. In solving any question it is advisable to draw the diagram accurately to scale; this will—even if the more accurate method of calculation be used—be found a good check on the results obtained.

If the given forces are in equilibrium, since R, the resultant, is equal to zero, we must have $\Sigma X = 0$, and $\Sigma Y = 0$. Hence the conditions of equilibrium for any number of forces acting in the same plane, and whose directions pass through a given point, are *the algebraic sums of the components in any two directions at right angles.* These must equal zero.

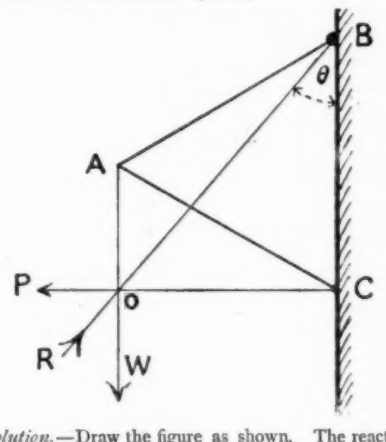
Questions—Advanced Stage.—(1) State and prove the rule for finding the resultant of two parallel forces acting towards the same part on a rigid body.

Parallel forces of 10 and 20 units act towards the same part at A and B; a force of 15 units acts from A to B; find the resultant of the three forces, and show in a diagram how it acts. (1886.)

Ans. 26·6 units.

(2) ABC is a rigid equilateral triangle (whose weight is put out of the question); the vertex B is fastened by a hinge to a wall, while the vertex C rests against the wall, under B; if a given weight is hung from A, find the reactions at B and C.

What are the magnitude and direction of the forces exerted by the weight on the wall at B and C? (1886.)



Solution.—Draw the figure as shown. The reaction R at C is horizontal; W is vertical, and the reaction R at B passes through O, the point of intersection of P and W; if θ denote angle RBC, then $\tan\theta = \frac{\sqrt{3}}{2}$; also $\frac{R}{P} = \frac{\sqrt{7}}{\sqrt{3}}$.

(3) Assuming that the 'parallelogram of forces' is true for the direction, show that it is true for the magnitude of the resultant. Find the cosine of the angle between the directions of forces of 5 and 7 units which have a resultant of 8 units. Show that the angle itself exceeds 90°. (1887.)

Ans. $-\frac{1}{7}$; the negative value indicating that the angle exceeds 90°.

(4) If R is the resultant of two forces, P and Q, acting at A, assuming the 'parallelogram of forces,' show that

$$R^2 = P^2 + Q^2 + 2PQ\cos PAQ.$$

Two forces in the ratio of 1 to 3 have a certain resultant when their directions contain a certain angle; the square of the resultant is doubled if the direction of one of the forces is reversed; find the angle. N.B. 9 sin 33° 43′ = 5. (1888.) Ans. 123° 43′.

(5) ABCD is a thread suspended from points A and D, and carrying a weight of 10 lbs. at B and a weight W at C; the inclination to the vertical of AB and CD are 45° and 30° respectively, and ABC is an angle of 165°; find, by construction or calculation, W and the tension of BC. (1891.)

Ans. $20(\sqrt{3}+1)$ lbs; $10(\sqrt{3}+1)$ lbs.

(6) ABC is an equilateral triangle formed of three weightless rods joined together at the ends; it is hung up by the point A, and a weight, W, is fastened to a point, P, in BC, such that 4BP = BC; find the position in which the triangle comes to rest, the stresses in the rods, and which rods are in compression and which in tension.

Ans. Tension in AB = ·831W; tension in AC = ·28W; compression in BC = ·21W.

(7) Draw a rectangle ABCD and its diagonals AC, BD intersecting at E, the lengths of AB and AC being 6 ft. and 10 ft., and let its plane be vertical and AB horizontal. Let AC and BD represent two weightless rods, turning freely round a pin at E, with their lower ends, A, B, connected by a thread, and standing on a horizontal plane. If a weight is hung at C, find the pressure on the ground, the tension of the thread, the stress on the pin at E, and the stresses in the rods themselves. How would the results be affected if C and D were connected by a thread instead of A and B? (1892.)

Ans. Re-action at B = W; tension of the thread = $\frac{3}{4}$W, where W = weight applied.

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FOR THE ADVANCED STAGE OF THE SCIENCE AND ART DEPARTMENT COURSE.

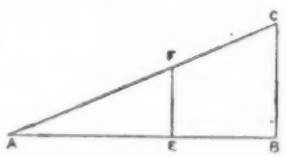
BY EDWIN EDSER, A.R.C.S.

Assistant in the Physical Laboratory, Royal College of Science; Member of the Physical Society.

Comparison of Resistances.

WHEN a current C flows through a wire of resistance R, it has been proved experimentally that the electro-motive force $E = CR$. This equation gives us a simple and at the same time most efficacious method of comparing two resistances.

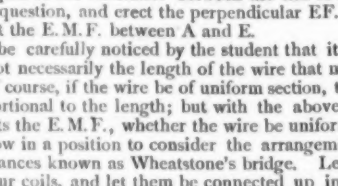
If we consider the electro-motive force between one end of a wire through which a current flows and any other point on it, we see at once that this force is proportioned to the resistance between the points. Therefore if we plot the resistances between the points as ordinates, and the electro-motive forces as abscissae, we shall find that the locus will be a straight line. Conversely, if we establish a certain definite electro-motive force between the ends of a wire, we can find the E.M.F. between one end and the end of a length having a resistance R by the following simple graphical method:—



Draw a horizontal line AB (Fig. 1) representing the total resistance of the wire, and at B erect a perpendicular representing the E.M.F. established between its ends. Join AC. Then to determine the E.M.F. between A and any point on the wire, take a length AE equal to the *resistance* between the end of the wire and the point in question, and erect the perpendicular EF. The latter will represent the E.M.F. between A and E.

It should be carefully noticed by the student that it is the *resistance*, and not necessarily the length of the wire that must be taken for AE. Of course, if the wire be of uniform section, the resistance will be proportional to the length; but with the above convention, EF represents the E.M.F., whether the wire be uniform or not.

We are now in a position to consider the arrangement for comparing resistances known as Wheatstone's bridge. Let R_1, R_2, R_3, and R_4 be four coils, and let them be connected up in the manner shown in Fig. 2. R_1, R_3, R_4, and R_2 are joined up in series, making



a complete circuit; the adjoining ends of R_1 and R_3 are then connected through a sensitive galvanometer G to the adjoining ends of R_2 and R_4; finally the two terminals of a battery E are joined to the adjoining ends of R_3 and R_4, R_1 and R_2 respectively. A small make-and-break key K is placed in the galvanometer circuit, and a similar one L in the battery circuit.

Suppose now that, these arrangements having been made, the key L be depressed, and subsequently, when the current has had time to acquire a steady state of flow, the galvanometer key K be depressed likewise, what are the conditions that there may be no deflection of the galvanometer? (*i.e.*, that there may be no current flowing through the wire *ab*).

The primary condition of course must be that the E.M.F. between *a* and *b* must be zero; and the problem now resolves itself into determining what must be the ratios between R_1, R_2, R_3, and R_4 that this may be so.

First of all, the battery maintains an E.M.F. (say) of E between *c* and *d*. Then if we proceed by the graphical method already indicated to determine the E.M.F. between *a* and *d*, we must plot $AE = R_1$, $EB = R_3$, and $BC = E$.

Now from similar triangles

$$\frac{EF}{CB} = \frac{AE}{AB}, \quad \therefore EF = CB\frac{AE}{AB}.$$

But EF = E.M.F. between *a* and *d*,

$$\therefore \text{E.M.F. between } a \text{ and } d = E\frac{R_1}{R_1 + R_3}.$$

$$\text{Similarly E.M.F. between } b \text{ and } d = E\frac{R_2}{R_2 + R_4}.$$

But E.M.F. between *a* and *b* = E.M.F. between *a* and *d* − E.M.F. between *b* and *d*.

$$\therefore \text{E.M.F. between } a \text{ and } b = E\left(\frac{R_1}{R_1 + R_3} - \frac{R_2}{R_2 + R_4}\right).$$

For this E.M.F. to be zero we must have

$$\frac{R_1}{R_1 + R_3} - \frac{R_2}{R_2 + R_4} = 0;$$

$$\therefore \frac{R_2 + R_4}{R_2} = \frac{R_1 + R_3}{R_1};$$

$$\therefore 1 + \frac{R_4}{R_2} = 1 + \frac{R_3}{R_1};$$

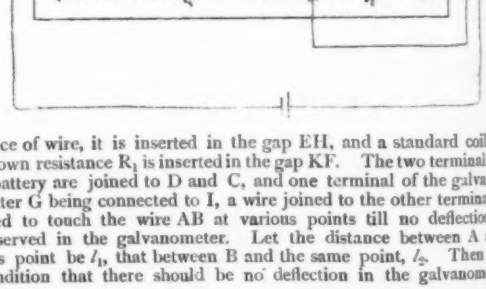
$$\therefore \frac{R_4}{R_2} = \frac{R_3}{R_1}, \text{ or } \frac{R_1}{R_2} = \frac{R_3}{R_4}.$$

If now R_1 and R_2 are capable of adjustment so as to give any ratio, and the value of R_4 be known, R_3 may be found by connecting the coils as already described, and altering the ratio $\frac{R_1}{R_2}$ till there be no deflection on depressing the keys L and K successively. Then

$$R_3 = R_4\frac{R_1}{R_2}.$$

A simple way of performing this comparison practically is as follows:—

A uniform wire AB is stretched on a board between two copper strips ACE and BDF, having connecting screws at C, E and D, F. Another strip of copper HIK is stretched on the board, having connecting screws at H, I, and K. To determine the resistance R of a



piece of wire, it is inserted in the gap EH, and a standard coil of known resistance R_1 is inserted in the gap KF. The two terminals of a battery are joined to D and C, and one terminal of the galvanometer G being connected to I, a wire joined to the other terminal is used to touch the wire AB at various points till no deflection is observed in the galvanometer. Let the distance between A and this point be l_1, that between B and the same point, l_2. Then the condition that there should be no deflection in the galvanometer gives

$$\frac{R}{R_1} = \frac{\text{Res. of } l_1}{\text{Res. of } l_2} = \frac{cl_1}{cl_2} = \frac{l_1}{l_2},$$

if we take *c* as the resistance of unit length of the wire AB;

$$\therefore R = \frac{l_1}{l_2}R_1.$$

Specific Resistance.

The specific resistance of a substance is the resistance which would exist between the two opposite faces of a centimetre cube of the substance.

To determine the specific resistance of a substance from measurements made on an ordinary piece of wire drawn from it, the following consideration must be taken into account:—

It can be proved experimentally that the resistances of various pieces of wire of uniform section vary as the lengths; whilst the resistances of a number of equal lengths of wire of different diameters vary inversely as the sectional area. Now let S be the specific

resistance of the substance as defined above, R the resistance of a length l of wire of radius r drawn from the substance.

Then the resistance of a length l of the substance of unit sectional area $= lS$; whilst if the sectional area be now altered to πr^2, the resistance will be $\frac{lS}{\pi r^2}$.

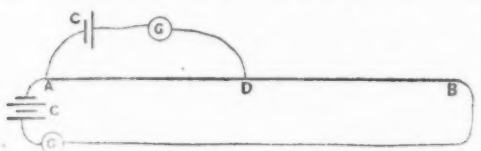
$$\therefore \quad R = \frac{lS}{\pi r^2},$$

$$\therefore \quad S = \frac{R \times \pi r^2}{l}.$$

Thus, from measurements of the resistance R, the length l, and the radius r of a piece of wire, the specific resistance of the substance from which it has been drawn can be determined.

Measurements of E.M.F.

The same equation $E = CR$ gives us a method of measuring the E.M.F. of a battery, thermo-junction, &c. AB (fig. 4) is a long wire,



connected in series with a battery C of higher E.M.F. than that to be measured, and a tangent galvanometer G. Supposing it is a cell of which the E.M.F. is required, it must be connected so that the pole joined to A is of the same sign as the pole of C joined to the same point. A sensitive galvanometer G^1 is then connected in series with it, and a wire joined to its other terminal is used to touch the wire AB at various points till a position is found where no deflection occurs.

Let E be the required E.M.F. of the cell C^1, then this will be the E.M.F. between A and the end D of the wire used for touching the wire AB. In order that no current should flow round the circuit AC^1G^1DA, the end of the touching wire D must have the same E.M.F. as the point D on the wire AB, which it touches. But if C be the current indicated by the tangent galvanometer G, and r be the resistance of the portion AD of the wire AB, then E.M.F. between A and D $= Cr$.

$$\therefore \quad E = Cr.$$

Also, if AD $= l_1$, AB $= l_2$, and the resistance of the whole wire AB $= R$, $r = \frac{l_1}{l_2} R$.

$$\therefore \quad E = \frac{l_1}{l_2} RC.$$

C is measured by means of the tangent galvanometer G by the method explained in a previous paper; R may be measured by means of a Wheatstone's bridge: so that all the elements necessary to completely determine E are obtained. The E.M.F. of cells can also be compared by placing each in succession in the position of C^1, and noting the length of the wire AB at which the point of no deflection in C^1 occurs. Then the E.M.F.'s in the various cases are proportional to these lengths.

The electro-motive forces of cells may also be compared by joining them successively in series with a high resistance galvanometer. If the deflections of the latter be small, they will be proportional to the current flowing through the coils. Let E be such an E.M.F., and let R be the resistance of the galvanometer, and r include all the external resistance in the circuit. Then if C be the current in the circuit, $C = \frac{E}{R + r} = \frac{E}{R}$ if r be small in comparison with R.

Therefore the deflections, being proportional to C, will be proportional to E, the E.M.F. joined to the terminals of the galvanometer. A high resistance galvanometer when used in this manner is often termed a *Voltmeter*.

It will be noted that the term 'difference of potential' has been avoided in the above descriptions, even at the cost of a certain sense of strangeness in the terminology used. As before remarked, 'difference of potential' really means *work*, and not *force*, and its use might lead to some confusion in the student's mind. The term occurs so commonly, however, that just a word seemed necessary to explain its absence; and with the above warning, the student, on finding the term used in other papers or text books, should experience no difficulty in distinguishing between the cases when *work* is really implied by it, and those when it is used as a synonym for electro-motive force.

Questions.

(1) The resistance of a length of 100 cm. of wire is measured and found to be 3 ohms, the diameter of the wire being ·1 m.m. What is the specific resistance of the substance of which the wire is composed? Give your answer (1) in ohms, (2) in C.G.S. units.

(2) An E.M.F. of 5 volts is maintained between the terminals of a circuit composed of an opposing E.M.F. of 1·1 volt and a resistance of 10 ohms. What current (1) in ampères, (2) in C.G.S. units, will flow through the circuit?

(3) Two wires of resistance 10 and 15 ohms respectively, are joined in parallel, and connected to a Daniell cell (E.M.F. = 1 volt). What current will flow (1) through the cell, (2) through either wire?

(4) Describe a simple method by which you could compare the E.M.F.'s of two cells, using only a tangent galvanometer, without any subsidiary resistances.

CHEMISTRY NOTES.

BY W. TATE, A.R.C.S., F.C.S.

HISTORICAL NOTES.—The view that all inorganic substances consisted of certain proportions of three fundamental earths, was taught by Johann Joachim Becher in his works, *Physica Subterranea* (1669) and *Theses Chymicæ* (1682). The older doctrine of Valentine asserting that all substances were composed of mercury, salt, and sulphur, was thus revived under a slightly altered form, the fundamental earths being termed the mercurial, the vitreous, and the combustible earths. The phenomena of combustion were explained as the result of the escape of the combustible earth (*terra pinguis*) from the burning substance.

On this basis, Stahl (1660–1734) developed the doctrine of *phlogiston*, of which Becher's terra pinguis may be viewed as the prototype.

According to Stahl and his followers, all combustible substances contained a common constituent, phlogiston, and this constituent escaped during combustion or calcination.

Though based on erroneous conceptions, the doctrine of phlogiston aided the development of chemistry by classing together the phenomena of oxidation and reduction, for oxidation was held to be due to the escape of phlogiston and reduction to the addition of phlogiston. The analogy between combustion and the processes of respiration and fermentative decomposition, was noticed by Stahl and explained by his theory.

No attention was generally paid to the known fact that by calcination, metals increased in weight, but Guyton de Morveau and Pierre Josèphe Macquer attempted an explanation by assuming that phlogiston possessed a negative weight, and hence its escape from a metal during calcination caused the product of calcination or calx (oxide as it is now termed) to weigh more than the quantity of metal calcined. A still more unscientific explanation was given by Juncker, who supposed that the metallic calces were heavier than the metals because they were denser. He confused density or mass per unit volume with total weight and also made an inaccurate statement, for Boyle had shown that the calces were specifically lighter (of less density) than the corresponding metals.

The unity of view by which many diverse phenomena were collated and explained on the assumption of this theory, led to its almost universal acceptance, notwithstanding the great obstacle raised by the above-mentioned consideration.

The chemistry of gases being almost unknown, it seemed that coal really decreased in weight by burning; here, then, was a substance consisting largely of phlogiston and burning vigorously in air because of the great escape of phlogiston. The production of a metal from its calx (or oxide) by heating with coal, was apparently easily explained as a transference of phlogiston from the coal to the calx.

Two ardent phlogistonists, Priestley and Scheele, paved the way for the overthrow of the doctrine of phlogiston, by their discovery of oxygen and demonstration of its properties. On their experimental work, Lavoisier based his simple and rational explanation of combustion as a combination of the combustible substance with oxygen. Many chemists regarded hydrogen as phlogiston; the method of producing oxygen by heating mercury calx (oxide) in a closed space, at the same time producing metallic mercury, effectually disposed of this view.

Finally the proof that water, hitherto thought to be an element, was a compound of hydrogen and oxygen, completed the evidence establishing the antiphlogistic view of combustion.

PRACTICAL NOTES.—Acetic acid may be contaminated with sulphuric acid, hydrochloric acid, copper, lead, and calcium. To test for sulphuric acid add HCl and $BaCl_2$, if present the usual white precipitate of $BaSO_4$ will be obtained. To test for hydrochloric acid it is necessary to dilute largely with distilled water and then add HNO_3 and $AgNO_3$, a curdy precipitate of AgCl indicates hydrochloric acid; if $AgNO_3$ be added to the acetic acid, without dilution, a white precipitate of silver acetate will be obtained. A few bubbles of hydrogen sulphide serve to show the absence of copper and lead. The presence of calcium is readily detected by its characteristic precipitate formed on addition of a solution of ammonium oxalate.

Oxalic acid may contain iron, calcium, sodium, and potassium salts. To examine for these impurities, ignite in a platinum capsule and test the residue, after solution in hydrochloric acid, in the usual way.

Ammonium carbonate may be rendered impure by the presence of lead and iron salts, sulphuric acid, and hydrochloric acid. The metals are immediately indicated by a brown or black stain on adding a drop of ammonium sulphide solution to the powdered carbonate. The carbonate is dissolved in nitric acid and the solution tested as usual for the foreign acids.

Ammonium chloride seldom contains other impurity than a little iron and sometimes calcium salts. Ignite on platinum and examine residue as usual.

Ammonium oxalate is subject to the same impurities as oxalic acid and may be examined in the same way.

Ammonium sulphide generally deposits a little ferrous sulphide on standing. It must be freshly prepared if required free from the yellow sulphides.

Sodium hydrate and carbonate are seldom free from alumina, silica, and sulphuric and hydrochloric acids, sometimes phosphoric acid also is present.

To test for silica, evaporate to dryness, with hydrochloric acid, a quantity of the carbonate or hydrate, dissolve the NaCl formed with hot water, wash the residue with strong HCl, and then with water, finally test with borax bead; silica remains undissolved in the clear bead at a red heat. To test for alumina, render just acid with hydrochloric acid, warm, and add slightly alkaline ammonium phosphate. A flocculent white precipitate insoluble in acetic acid indicates alumina. For foreign acids, dissolve in excess of nitric acid, and test as usual.

Potassium chromate, or sodium chromate, may contain sulphates and chlorides. Dissolve in a large quantity of dilute nitric acid, and then test as usual for H_2SO_4 and HCl. Sodium chromate has been met with containing over 90 per cent. of sodium sulphate.

Potassium bichromate is generally very nearly pure; it may be tested in the same way as the chromate.

Potassium iodide generally contains potassium iodate, and sometimes the carbonate is also present. To test for iodate, add very dilute well-boiled sulphuric acid, and a little starch paste; a blue colouration is sufficient evidence of its presence. For the carbonate a large quantity of the salt is placed in a flask with dilute sulphuric acid and heated, the evolved gas being passed into lime-water as usual.

Barium chloride may contain a little of the strontium salt; test with flame reaction; transient crimson flashes indicates this impurity.

Calcium chloride may also contain strontium chloride, and a trace of the iron salt. For strontium, add to a clear and very concentrated solution a large bulk of calcium sulphate solution, boil, and set aside for two hours; a white precipitate indicates strontium.

For iron, add a little ammonium sulphide; a greenish colouration is given by mere traces; on standing, ferrous sulphide settles out.

Copper sulphate may contain iron, and sometimes zinc salts. For iron, add to the solution an excess of potassium sulphocyanide, and shake with ether; the ethereal layer will be reddened by ferric sulphocyanide if present. (N.B.—First boil with a few drops of chlorine water to ensure oxidation of the iron.) If zinc be suspected, precipitate the copper with excess of potassium sulphocyanide and sulphurous acid. Boil off excess of SO_2, and pass hydrogen sulphide through the filtrate; examine any precipitate of sulphides in the usual way.

References.

Journal of the Chemical Society, March 1895. 'Mercury and Bismuth Hypophosphites,' by Seihachi Hada, pp. 227–229.

'Specific Heats of Gases at Constant Volume: Carbonic Anhydride,' by J. Joly, pp. 69–70.

'Concentration and Distillation of Hydrogen Peroxide,' by R. Wolffenstein, pp. 73–74.

'Formation of Hydrazine from Inorganic Compounds,' by P Duden, p. 74.

'Thioacetic Acid as a Substitute for Hydrogen Sulphide in Qualitative Analysis,' by R. Schiff and N. P. Tarugi, p. 84.

'Electrolytic Separation of Iron and Cobalt from Zinc,' by G. Vortmann, p. 89.

Notes on Questions.

Adv. (14).—The hypochlorite in bleaching powder can be converted into chlorate by solution in water, the addition of free chlorine and raising the temperature of the solution. Raising the temperature alone is insufficient to convert more than a small part of the hypochlorite into chlorate. The reaction may be represented as follows:—

(*a*) $3Ca(OCl)_2 + 2Cl_2 + 2H_2O = CaCl_2 + 4HOCl + 2Ca(OCl)_2$.

(*b*) $CaCl_2 + 4HClO + 2Ca(OCl)_2 = 2CaCl_2 + Ca(ClO_3)_2 + 2Cl_2 + 2H_2O$.

Potassium chlorate is formed from calcium chlorate by double decomposition with potassium chloride, thus—

$$Ca(ClO_3)_2 + 2KCl = CaCl_2 + 2KClO_3.$$

The resulting liquor is concentrated in iron pans, when most of the $KClO_3$ crystallizes out, and is purified by recrystallization.

Adv. (15).—The *equivalent* of an element is the weight of that element which will combine with or replace one part by weight of hydrogen. A *molecule* is that smallest particle of any substance capable of free existence while retaining the properties (chemical) characteristic of the substance. The *atomic weight* of an element is a number expressing the ratio of the mass of an atom of the element to the mass of an atom of hydrogen. *Valency* is the term given to that property of atoms which decides how many atoms of hydrogen can be replaced by or combine with one atom of the element; it is expressed by a number. The *molecular weight* of a gaseous element or compound is a number which expresses the ratio of the mass of a volume of the gas (or vapour) to the mass of an equal volume of hydrogen taken as 2; the molecular weight cannot yet be given with absolute certainty for any substances in the liquid or solid state. The atomic weight of copper may be accurately determined by (*a*) ascertaining its chemical equivalent by analysis or synthesis; (*b*) determining its specific heat, and hence by means of Dulong and Petit's Law ascertaining what multiple of the equivalent represents the atomic weight.

Adv. (16).—As in the case of copper, the equivalent must first be ascertained accurately by analysis or synthesis, but the specific heat method no longer allows us to choose the appropriate multiple of the equivalent, for carbon and oxygen do not obey Dulong and Petit's Law. An examination of the composition of all the known gaseous compounds of oxygen and of carbon having been made, we choose that multiple of the equivalent for the atomic weight which equals the smallest weight of the element present in the molecular weight of any of its compounds. This evidently must be the *maximum possible atomic weight* of the element.

Adv. (17).—See Newth, p. 208. N_2Mg_3 will yield N_2, that is, $(2 \times 14) + (3 \times 24) = 100$ grams of magnesium nitride yield 22·32 litres of nitrogen, dry and at 0° C. and 760 mm. Therefore 10 grams will yield, at 772 mm. and 17° C., the volume $x =$

$$\frac{22{\cdot}320 \times 10 \times 760 \times 290}{100 \times 772 \times 273} = 2{\cdot}334 \text{ litres.}$$

Adv. Prac. (9).—Method for examination of insolubles will be given in next number.

Adv. Prac. (10).—(*a*) Reduce the arsenate by boiling with concentrated hydrochloric acid and potassium bromide, and then precipitate the arsenic as sulphide, filter and test filtrate for phosphoric acid with a nitric acid solution of ammonium molybdate at about 60° C. after first ascertaining that arsenic has been completely eliminated. (*b*) Dissolve in concentrated hydrochloric acid, add alcohol, and boil to reduce the chromic acid, evaporate nearly to dryness, dilute with distilled water, cool and filter off lead chloride, precipitate the remainder of the lead by means of hydrogen sulphide, filter and add sulphuric acid to the filtrate, an immediate white precipitate indicates the presence of barium. Reduction with hydrogen sulphide or sulphurous acid is not advisable in this case, as sulphuric acid would be produced in the reaction and a precipitate of sulphates formed which might contain both lead and barium, and hence the *separation* of the latter fail. (*c*) Ignite the platinochlorides on a clean platinum capsule; they decompose as follows:—

$$K_2PtCl_6 = 2KCl + Pt + 2Cl_2$$

$$(NH_4)_2PtCl_6 = 2NH_3 + 2HCl + Pt + 2Cl_2.$$

Exhaust the spongy platinum with water, concentrate the solution and add a drop of platinum chloride solution, a yellow crystalline

precipitate indicates the previous presence of potassium salt in the substance taken for ignition.

Hon. (13).—Read Chapter IV., pp. 96-108, in Meyer's 'Modern Theories of Chemistry.'

Hon. (14).—Let x = the amount of silver chloride, then $(2{\cdot}372 - x)$ must be the amount of silver bromide given by 0·9890 grams of phosphoryl bromochloride. For such a *phosphoryl* compound the composition must agree with the general formula $POBr_a Cl_b$ where $a + b = 3$.

We have, then, (1)

$$\frac{x \times 35{\cdot}5}{(108 + 35{\cdot}5)} = \frac{0{\cdot}9890 \times (b \times 35{\cdot}5)}{(31 + 16 + a.80 + b.35{\cdot}5)} \text{ for chlorine,}$$

and (2)

$$\frac{(2{\cdot}372 - x) \times 80}{(108 + 80)} = \frac{0{\cdot}9890 \times (a \times 80)}{(31 + 16 + a.80 + b.35{\cdot}5)} \text{ for bromine.}$$

As $a + b = 3$ we have $a = 3 - b$.

Hence, (1′)

$$\frac{x}{143{\cdot}5} = \frac{0{\cdot}9890 \times b}{\{47 + 80(3 - b) + 35{\cdot}5b\}}$$

and (2′)

$$\frac{(2{\cdot}372 - x)}{188} = \frac{0{\cdot}9890 \times (3 - b)}{\{47 + 80(3 - b) + 35{\cdot}5b\}}.$$

Solving for (b) we get, by elimination of x and reduction, $b = 2$, and $\therefore a = 3 - b = 1$.

Hence the result agrees with the formula $POBrCl_2$.

Hon. (15).—See last number.

EXERCISES.

Advanced Stage.—(18) Describe the manufacture of phosphorus. How would you prepare the hydrogen phosphides? (19) What is the 'basicity' of an acid? How would you determine the basicity of Nitric, Hydrochloric, Sulphuric, and Phosphoric acids? (20) Give full details of the method you would use to make (*a*) potassium permanganate, (*b*) manganese sulphate from pyrolusite contaminated with quartz and barytes.

Advanced Practical.—(11) For what purposes would you use (*a*) lead dioxide, (*b*) cadmium carbonate, (*c*) barium carbonate in qualitative analysis? (12) Give an account of the application of 'iodide film' reactions in the dry way.

Honours.—(16) Describe the reactions taking place in the ammonia-soda process, and point out the advantages and disadvantages which the process offers over the Leblanc method. (S. and A. D. 1894.) (17) What difficulties would be met with in the analysis of a spathic iron ore containing manganese, and what method would you propose to use in order to avoid these difficulties? (18) Describe Moissan's recent work with the electric furnace in the production of some of the rarer elements in quantity.

REVIEWS.

Blackie's Drawing Sheets: Standards I. to VII. and Block Lettering. London: Blackie & Son, Limited.

This series of Drawing Sheets is very complete, and is distinguished by exact suitability to the requirements of the Drawing Syllabus, and by the remarkable way in which the Teacher's convenience has been considered. For each Standard is provided a 'leather-board' box, strengthened with tin-bound corners, and containing twenty-four sheets of strong manilla paper. On these sheets are printed in a clear bold style a capital selection of exercises and artistic designs graduated according to the Standard. To facilitate the display of the sheets on a board in front of a class, eyelet holes edged with metal and strengthened on each side of the paper, are placed at the four corners, so that drawing pins may be used to fasten up the sheets without damaging them.

The educational character of the series appears in the careful graduation, the variety of types of design, the small sketches printed at the side of most of the copies to illustrate stages of construction, and the indication of the different principles on which the designs are based, as balance, proportions, growth, grouping, tangential curves and radiation.

The set of copies for Standard I. is limited to straight line examples, but opportunity is taken to impress on the young scholar's mind the meaning of elementary terms. The second set consists of rather more advanced figures formed by straight lines, but it is made in some degree to overlap the work of Standard III. by affording some preliminary practice in curved line forms. In Standard IV. objects and simple scales are given as well as ornamental designs for practice in freehand. Standard V. includes a number of copies illustrating the principles of model drawing as well as an assortment of freehand examples of ornament, plants, and common objects. Each of the sets for Standards VI. and VII. contains a dozen excellent designs for freehand drawing, and a dozen sheets of exercises in solid geometry, which provide for abundant practice in drawing plans and elevations of regular solids and sections of the same.

Every box contains several freehand copies which have been given at the Government examinations, and there are many features which prove the scheme of the series to be the work of a thoroughly practical mind. We have put the value of the sheets to the test of actual experience, and find their merits to be fully established. Teachers cannot fail to find them suitable in arrangement and convenient and economical in use.

A separate box of thirteen sheets contains a well-designed block-letter alphabet drawn to scale and affording good practice for Standards III. and IV.

Townley Geographical Reader for Standard VI. Edited by A. Park, F.R.G.S., etc. London and Edinburgh: McDougall's Educational Company, Limited.

This is a noteworthy addition to the considerable number of geographical reading books to choose from, which is frequently an embarrassing task for the Teacher. Several features specially commend it to one's attention. It is a substantial volume of nearly 300 pages, printed in remarkably clear type, and strongly bound in a blue cloth cover bearing an attractive coloured design.

The sixty-four lessons in which the subject-matter is presented are pleasantly written, and deal with the British Colonies and Dependencies in all parts of the world. The interest is varied and increased by the insertion of lessons on the history of our career of colonisation and conquest. Among the lessons of this special character may be mentioned those entitled 'How our Empire is protected,' 'On an Ironclad,' 'The Overland Route as it once was,' 'As it now is,' 'The Indian Mutiny,' 'A Settler's Life,' 'African Exploration.'

In the lessons on India, the modern and more correct way of spelling proper names is adopted, but in most cases the more commonly received spelling is added in brackets.

The substance of each lesson is summed up in a paragraph at its close. The information appears to be well abreast of our time, changes as recent as those of last year being noted.

Eight very clear colour-printed maps, and a large number of capital illustrations add to the usefulness and attractiveness of the volume. With so many merits this Sixth Standard Geographical Reader is pretty sure to be widely appreciated.

The Pitt Press Shakespeare: A Midsummer Night's Dream, with Introduction, Notes, Glossary, and Index. By A. Wilson Verity, M.A. Cambridge: At the University Press.

Mr. Verity's work is marked by fulness of detail, and a scholarly mode of handling all questions of language and literary criticism. The Introduction occupies over thirty pages, and is divided into twenty sections, each of which treats of some special matter, such as 'the date of publication,' 'the probable date of composition,' 'the title of the play,' 'probable sources of details of the plot,' 'Fairy Lore of the Play,' 'the Story of the Lovers.' All are dealt with very fully, and so much light is thrown on the meaning of the play as a whole.

The notes are generally well suited to their purpose; but we are struck in some places by what may be termed a want of proportion or similarity of treatment. Some explanations are given which one can hardly imagine any one needing if he is able to read Shakespeare at all, while others presuppose a considerable amount of learning on the part of the student, or at least ability to appreciate learned criticism. As examples of the former we note 'live' is explained as 'reside,' Act II. scene 1, 13, and in the same scene, line 227, 'brakes' is explained as 'thickets.' On the other hand, the note on 'the Man in the Moon,' Act V. scene 1, refers the reader to *Genesis*, *Numbers*, Dante's *Inferno* and *Paradiso*, Dr. Brewer's *Reader's Hand-Book*, Grimm, and one of Ben Jonson's Masques; and in the explanation of 'triple Hecate' in the same scene, quotations are made from Vergil's *Æneid*, Ovid's *Metamorphoses*, and Milton's *Comus*.

Again, Dr. Verity never seems to trust the pupil to see a joke unaided, the most obvious pun must needs be pointed out, if not made the subject of further comment.

The Glossary to which the reader is referred for all points having a philological bearing, is an admirable piece of work, and is full of interest. The same may be said of the Appendix, which traces Milton's probable indebtedness to the play, and of the Hints on Shakespeare's English.

Altogether this edition affords ample guidance to the young student, and may be consulted with advantage by many more advanced ones.

Blackie's English Classics: Goldsmith's Deserted Village. Edited by Elizabeth Lee.

Macaulay's Armada, Ivry, and Battle of Naseby, with Introduction and Notes. London: Blackie & Son, Limited.

These little books are admirable specimens of their kind. They are neatly and clearly printed. The biographical sketches and historical introductions are simply written and exactly suited for young readers. The notes which are brief and to the point give every explanation that can be needed.

King and Parliament (A.D. 1603–1714). By G. H. Wakeling, M.A. London: Blackie & Son, Limited.

With the object of meeting the needs of those students and classes of pupils who may be studying some special period of English History, the well-known educational publishers, Blackie & Son, have projected a series of small historical text-books under the general title 'The Oxford Manuals of English History.' They are written by resident members of the University of Oxford actively engaged in teaching in the Final School of Modern History, and the general editor of the series is Mr. C. W. C. Oman, a Fellow of All Souls, already known as the writer of two or three works on historical subjects.

One special feature is to be the uniformity of scale in the treatment of the six periods into which, for the purpose of this series, the course of English History has been divided. This and the general editorship will, it is expected, enable a student to study the manuals, if need be, in succession without forming wrong ideas of proportion. The complete series should also form a homogeneous text-book.

'King and Parliament,' the first book in order of publication is Number V. of the series, and treats of the period from 1603 to 1714, that is the time from the accession of the first of the Stuarts to the death of the last of that ill-starred dynasty. Mr. Wakeling presents the facts in a clear and impartial manner. Through all the changes he has to trace he keeps his main subject well in view, and the essential characteristic of the period is shown to be the great struggle between the Sovereign and the people, a struggle which resulted in the triumph of the latter.

The style in which the work is written is crisp, and in some places may be called epigrammatic. Anyone who cares for the study of history will be likely to find Mr. Wakeling an agreeable guide over a somewhat difficult tract.

We have been struck by one omission—rather a large one. There is scarcely a reference to the literary life of the period. Lord Bacon is just mentioned. But Milton, Dryden, and Addison, each of whom had some relation to the general history of the time, and to the varying fortunes of the great conflict of interests, are not so much as named.

The volume presents a neat appearance, and in regard to print and paper is a satisfactory production.

Pierre et Camille. By Alfred de Musset; with Notes and Vocabulary by Rev. J. Hewetson, M.A. London: Relfe Brothers.

Alfred de Musset's pretty and interesting story of two deaf-mutes is a very suitable selection for the Oxford Local Examination in French. Though slight it is instructive, and while it has some decidedly French features, it is not unwholesome. The style is simple and graceful, and the little work is likely to be enjoyed by young students.

The annotations are of a serviceable kind and are sufficient for their purpose, especially as a tolerably full vocabulary is added. But we regard it as a serious fault in a book intended for young learners that there should be need for a long list of *errata* such as we find on an inset between the text and the notes. These *errata* include incorrect spelling, misplaced and omitted accent marks, and errors in grammatical description of various words. The printed list of *errata* is incomplete, for we notice in the text the following additional misprints:—*bizzare* for *bizarre*, *rir* for *air*, *sérieus* for *sérieux*. Surely an examination edition of a French classic should have been revised with greater care than can have been bestowed on this otherwise satisfactory class-book.

Blackie's English Classics: Macaulay's Battle of Lake Regillus. Selections from Shakespeare's As You Like It. London: Blackie & Son, Limited.

These additions to a well-edited series of booklets are likely to become favourites. Macaulay's spirited Lay, full as it is of classical allusions, affords abundant opportunity for instructive elucidation, and the annotator has taken full advantage of this. The references to Latin and Greek authors, and quotations from their works, are very numerous, and such illustrations make the reading of the poem a genuine and interesting bit of literary study.

The other booklet contains seven scenes from 'As You Like It,' extending to about 700 lines, preceded by a brief narrative of the plot, and followed by a capital set of brief notes.

The School Music Review. January and February. London; Novello, Ewer & Co.

This monthly publication contains in its letterpress much that will interest the teacher of music in schools. The articles treat of such subjects as 'Pitching Keys,' 'Sight Singing in Public Schools,' 'The Ethics of Singing for Children.' Vocal Competitions and Juvenile Concerts are described, and details are given of various examinations in music. Each number contains a series of technical exercises, some in the staff notation and some in sol-fa, and also a selection of school songs in unison and in parts. The January issue contains a three-part arrangement of 'God Save the Queen,' unison pieces by Beethoven and Mendelssohn, with accompaniments, and as a supplement, 'Under the Greenwood Tree.' That for February has a new duet, 'The Sparrow,' and the supplement is Dr. Arne's setting of 'Where the Bee Sucks.' The voice parts are given in both notations.

The New Readers: Book Sixth. London: A. M. Holden.

As might be expected in Professor Meiklejohn's Series, this Sixth Reader presents us with an admirable selection of literary pieces of high merit, as well as varied, fresh, interesting, and truly representative. Passages are given from our

best poets, novelists, essayists, and historians; and, as a distinctive feature, may be mentioned a series of lessons which appear to have been specially compiled on famous British Strongholds. These are full of interesting details—historical, legendary, and topographical.

Pleasantly written biographical sketches of the authors represented are placed near the end of the book, the last few pages being occupied by lists of Latin prefixes with interesting explanations. In one of the biographies the expression 'at Oxfordshire' has escaped the editor's notice.

The pictorial illustrations, particularly those of the castles, are very good, and the typographical and other material qualities of the volume are worthy of all praise.

The Townley Standard Geographies. Standard V.: Europe, etc. With Coloured Maps and Diagrams. By an Inspector of Schools. London: McDougall's Educational Co., Ltd.

The memory work of Standard V. is here presented very clearly in brief form. There are five effective coloured maps, and diagrams are given to assist in explaining latitude, longitude, day and night, and the seasons. An appendix contains interesting facts on the 'Main Routes to the Continent,' 'Famous Buildings in Europe,' and 'Notes on the Alps.' As a summary of oral lessons in class, the book is likely to prove really useful.

Capi et sa Troupe. Épisode de 'Sans Famille.' Hachette & Co.

The belief that pupils most readily learn French by reading the classical work of Racine or Molière is now pretty well exploded, and interesting and attractive extracts from modern writers are now more usually found in schools. The extract from M. Malot's masterpiece before us is of the kind which render the acquisition of French a real pleasure. There are few boys or girls who would not become interested in the varying fortunes of Rem and his companions. Judicious notes and a vocabulary have been added by Mr. Tarver, French Master at Eton.

Matriculation Directory. University Tutorial Series. Clive, Paternoster Row.

The U.C.C. has made itself nearly indispensable to students who propose taking a London Degree.

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Royal School Arithmetics. Scheme A. Code 1894–5. No. VI. and No. VII.

In these little books, while short space is devoted to explanations of rules or methods, the examples for practice are very numerous. One noteworthy feature is the grouping of the examples in each exercise in three or four sets of corresponding difficulty, and another is the bold black type used for the numerals.

The Student's English Dictionary. Ogilvie and Annandale. Blackie & Son.

One of the most indispensable books of reference to the ordinary reader or student is a good English Dictionary, and Ogilvie's has long enjoyed a great reputation as a reliable work. The old edition has been thoroughly revised and augmented, and the result is before us in a New Edition, which is practically a new work. It contains extensive appendices and nearly eight hundred engravings, the explanations are always clear and correct, the derivations reliable, and special attention has been paid to the very numerous scientific and quasi-scientific words which have been introduced of recent years into the language.

The work occupies an important place between the ordinary school dictionary and the unwieldy encyclopædia, and should be in the hands of every student and reader. It is in every respect an excellent book, and will meet with universal approbation.

Vere Foster's Copy Books. Bold Writing, 18a. Arithmetical Figuring, Elementary. London: Blackie & Son, Limited.

An additional copy-book which contains examples of clear bold figures with space for abundant practice. The models include sums and Examination Papers fully worked out, and many of the lines of figures are suggestive of the arithmetical tables.

'Tuck-up' Tales. By Aunt Dweedy. London: T. Nelson & Sons.

The lady who calls herself 'Aunt Dweedy' has produced a delightful set of tales for the little folks. They deal with just the subjects that children revel in—fairy-land and Father Christmas, toys and childhood's adventures—and they instil wholesome morals in the pleasantest of ways. They are admirably adapted to the purpose signified in the title—that is, for telling or reading to the little ones when they go to bed. Children of ten or twelve would find a pleasant task in reading them to their younger brothers and sisters.

The style is charmingly simple, but an expression here and there might be improved, for example, 'she became beside herself.'

Bound in a dainty decorated cover, the volume is very suitable for a little gift-book.

Arithmetic for the Standards. By C. Pendlebury, M.A., F.R.A.S., and W. S. Beard, F.R.G.S. Standards I., II., III., and VII. London: George Bell & Sons.

Teachers who are acquainted with the excellent class-book on Arithmetic by Mr. Pendlebury, and the remarkable collection of examples which it embodies, will welcome these small books for the standards, in the preparation of which the skill of the Senior Mathematical Master of St. Paul's has been re-inforced by his coadjutor's acquaintance with the needs of elementary schools.

The book for Standard I. contains practical hints for young teachers on the method of developing the rudimentary ideas of number and of the simplest arithmetical processes, and a large number of exercises for the pupils. The next two books contain explanations which have the merit of being brief, clear, and simple; and the last number completes the course required, not only for Standard VII., but for pupils in Higher Grade Elementary Schools, candidates preparing for Scholarships to Secondary Schools, and scholars in Evening Continuation Schools. In this part the explanations are somewhat fuller, and the exercises, which are very numerous, have been carefully classified.

Arithmetic. With numerous Examples and Exercises. Arranged by A. E. Layng, M.A. Part I. London: Blackie & Son, Limited.

Judging from the first part, which extends from Notation and the Simple Rules to Fractions, Vulgar and Decimal, and the Unitary Method, Mr. Layng's Arithmetic is an admirable text book. The first half of the volume, extending to nearly 140 pages, is occupied with what is called Book-work. This includes definitions, explanations of rules and methods, and many worked examples.

The explanations are marked by extreme clearness and directness of statement. The worked examples are models of concise and intelligible arrangement. Time-saving and

space-saving devices are freely adopted. The whole plan seems to be characterised by plain common sense and an absence of the merely conventional.

The examples for practice which occupy the latter half of the volume are about 5,000 in number, and are arranged in forty-three exercises. Except in the miscellaneous exercises, of which large collections are given at intervals, the examples are arranged in pairs, so that those under odd numbers will form one tolerably complete series, and those under even numbers a similar or almost parallel series. Suggestions as to the mode of using the examples are made in the preface, and the arrangement is such as to adapt the work to the needs of different classes of students. The examples may be had separate from the book-work, and with or without the answers.

This Arithmetic will be a capital one for pupil teachers and candidates for Civil Service and other examinations, as well as for middle-class schools. The type, paper, and binding are all very satisfactory.

The second part is to treat of the Commercial and Higher Rules.

Blackwood's Mental Arithmetic. Standards I. to VI. and VII. London and Edinburgh: William Blackwood & Sons.

This handbook of Mental Arithmetic is intended for the teacher's use. It is issued complete in volume form and also in six parts, corresponding to the standards of the Education Code, the last part being adapted to meet the requirements of Standards VI. and VII. The first pages of each part contain practical hints on the kind of work to be done, and the best ways of securing rapid and intelligent calculation. Then follows in each book a collection of 1,200 examples arranged in 80 sets of 15 each, and with the answers printed in the margin. The earlier exercises are classified according to the type of question illustrated, the later ones have the questions mixed. Two points are specially noticeable, the great variety of form in which the examples are given, and the large proportion of them which are of a concrete character.

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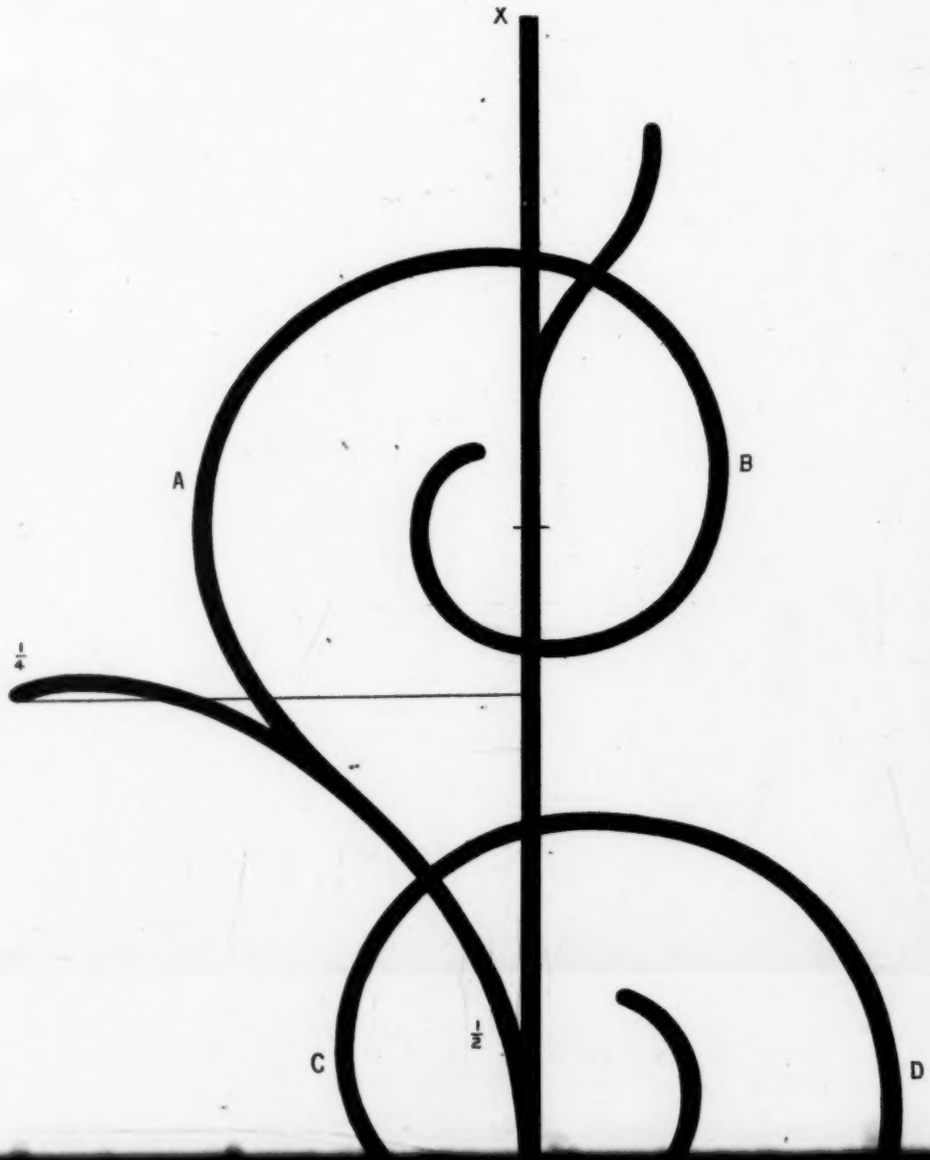

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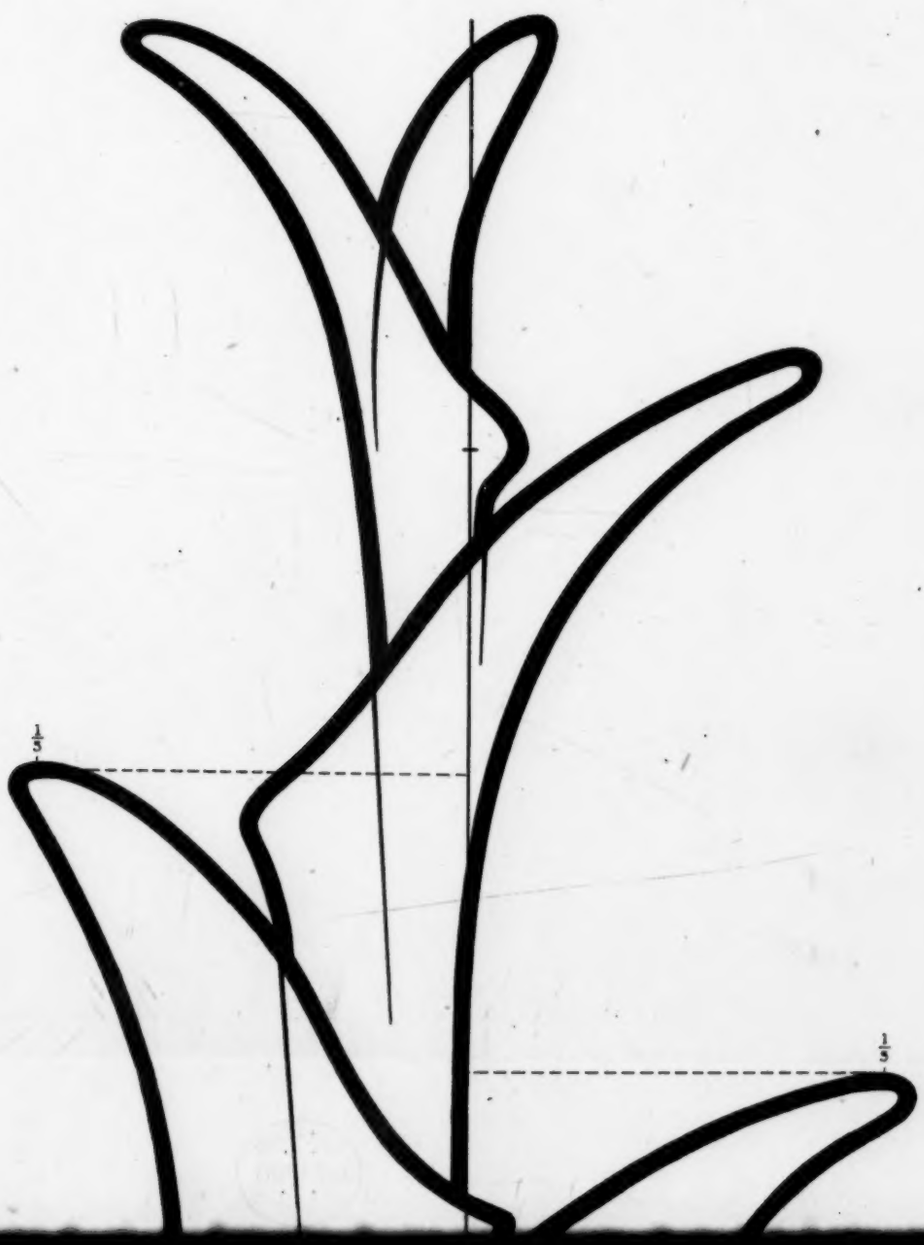

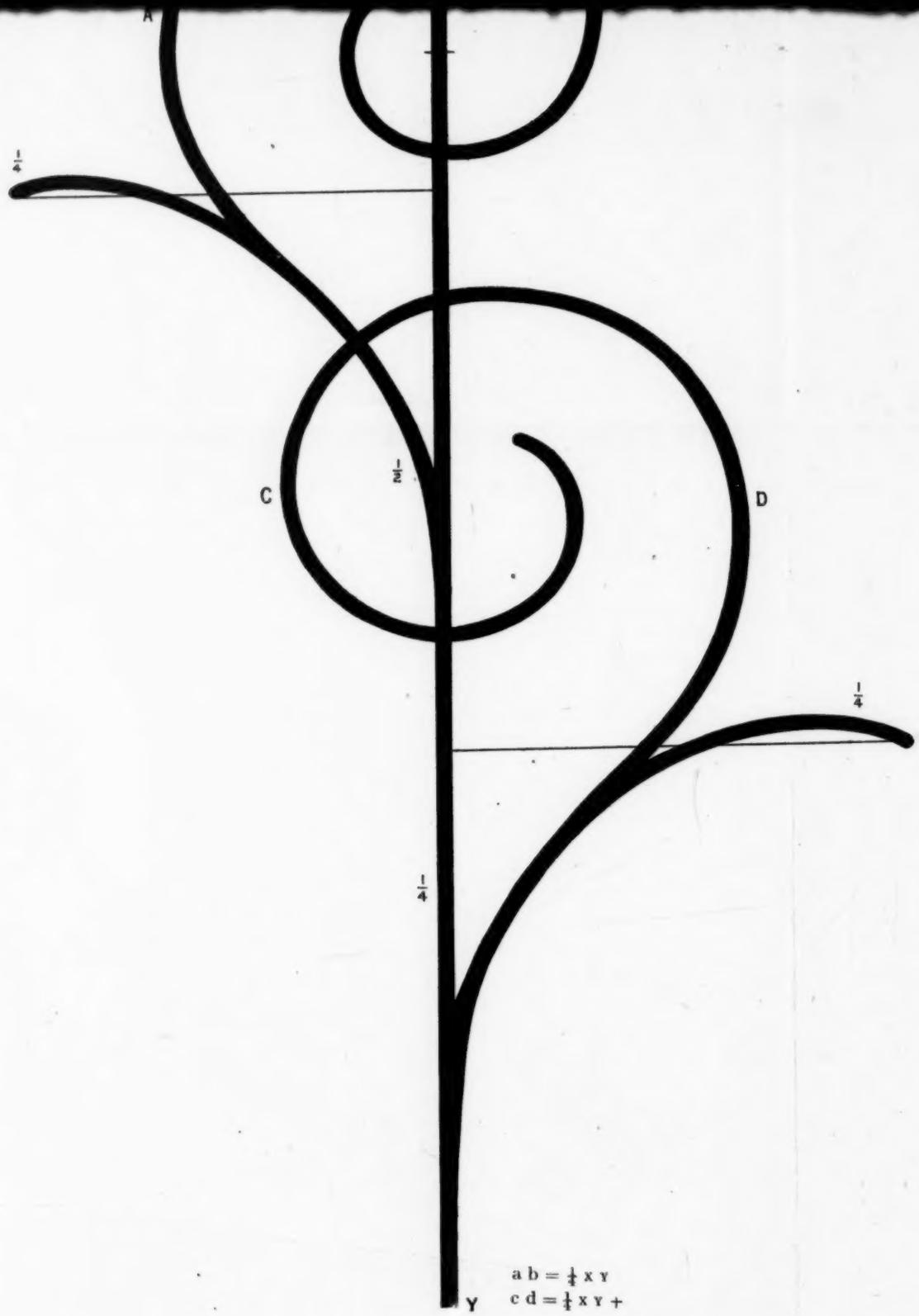

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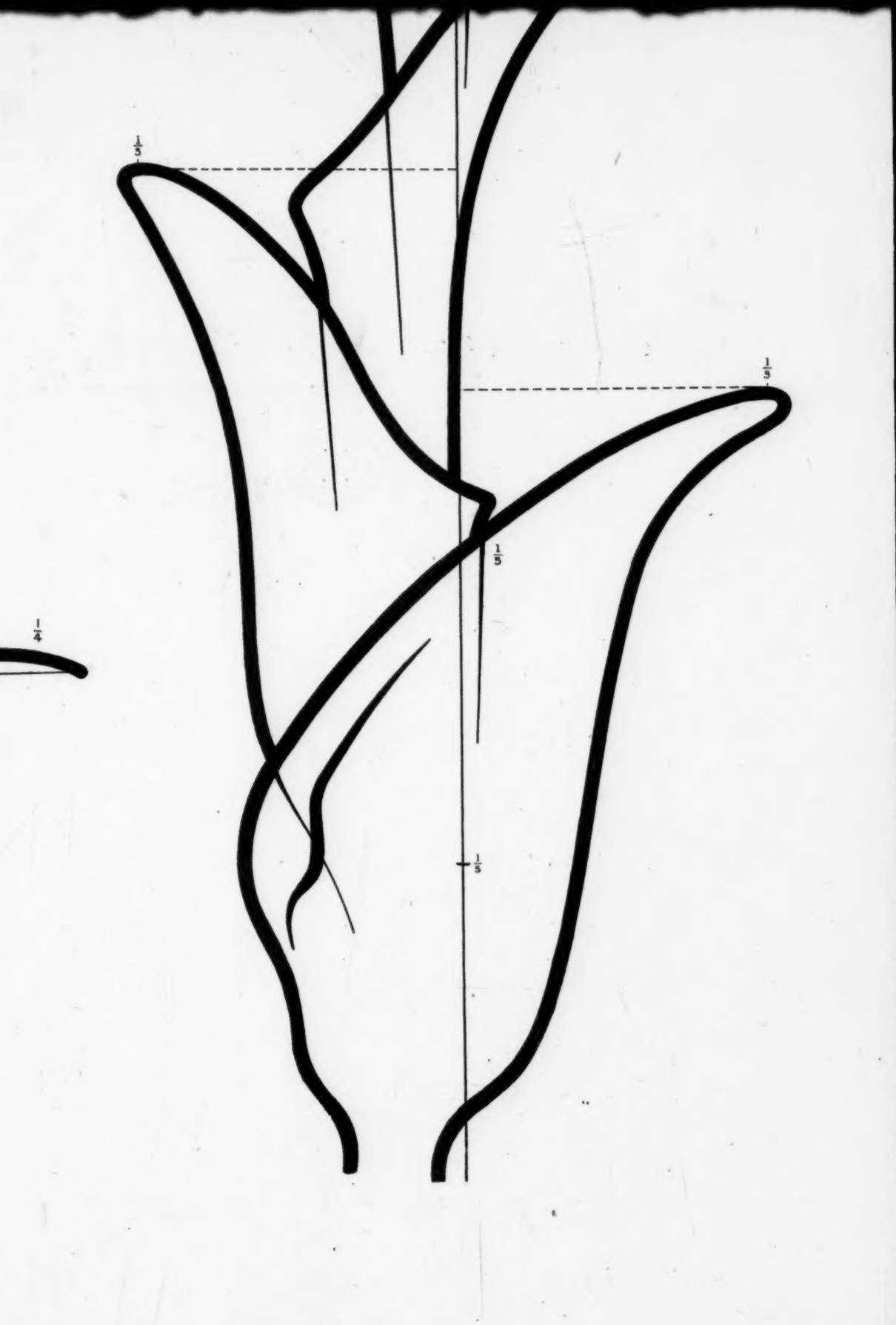

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